General Report
on the
Operations of the Survey of India Department administered under the Government of India
1893-94 & 1894-95

00134602

BOMBAY BRANCH
OF THE
ROYAL ASIATIC SOCIETY.
TOWN HALL, BOMBAY.

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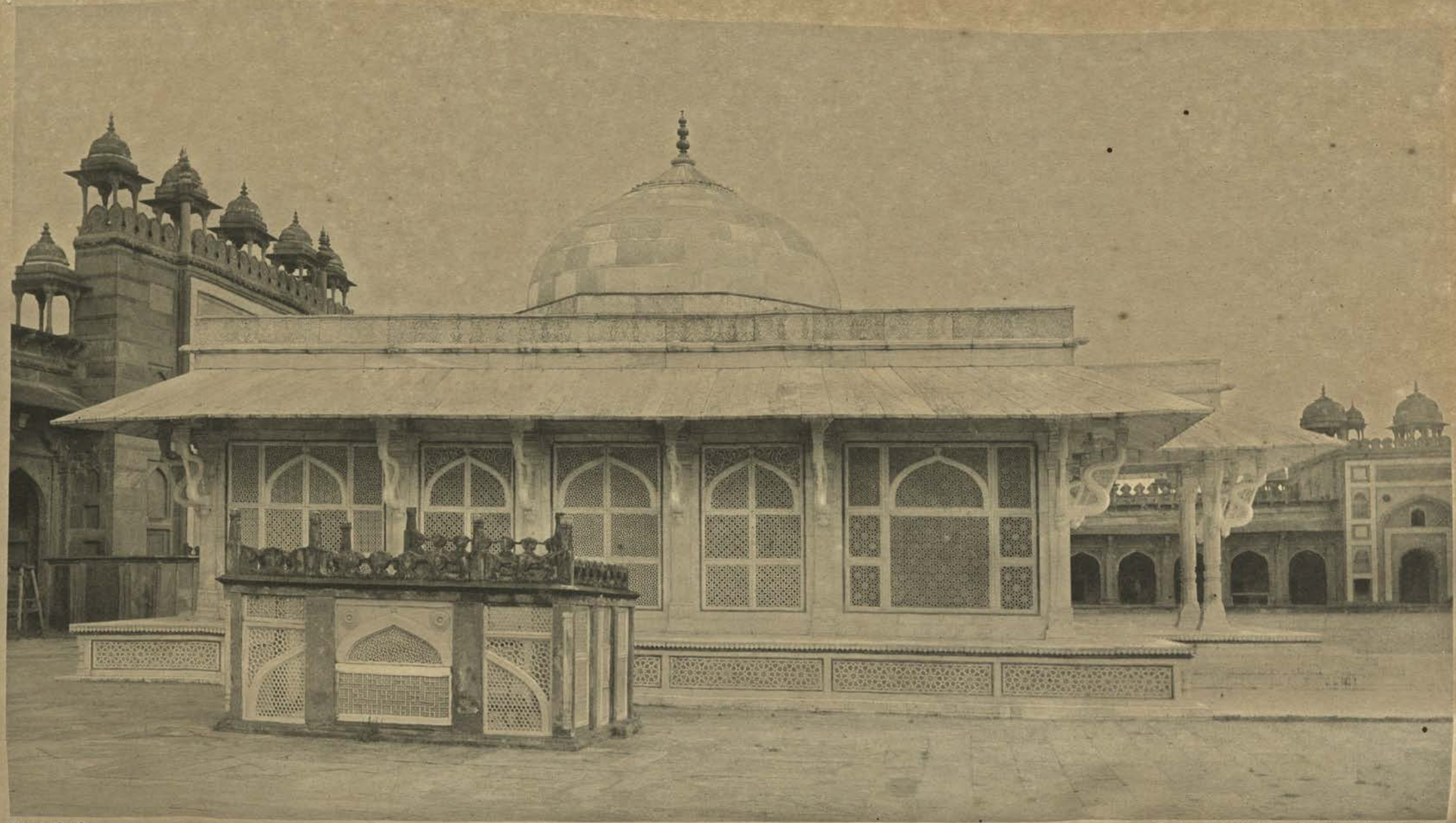

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Survey of India Offices, Calcutta, January 1895.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1893-94. d 1894-9

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SURVEYOR-GENERAL OF INDIA.

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CONTENTS.

PART I.

SUMMARY.

	PAGE
Administration	1
Field Parties	3
Outturn	5
Trigonometrical Surveys	5
Topographical Surveys	5
Forest Surveys	5
Cadastral Surveys	7
Traverse Surveys	10
Special Operations	11
Geographical Surveys	12
Head-Quarters Offices	12
Establishment	15

RETROSPECT.

Operations from 1886 to 1894	16

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

No. of Party.		PAGE Report.	PAGE Appendix.
	Trigonometrical Surveys.		
24.	Burma and the Indus Delta coast	19	i
	Topographical Surveys.		
10.	Southern Maratha Country	20	...
15.	Baluchistan	21	iii
18.	Himalayas, Punjab	23	...
Det.	Aden and the Yafi'i Country	25	...
„	Indus River, Sind	27	...
	Forest Surveys.		
14.	Central Provinces	28	...
17.	Bombay Presidency	31	...
19.	Madras Presidency	34	...
20.	Lower Burma	35	...
	Operations of the Forest Survey Branch	38	...
	Cadastral Surveys.		
2 & 8.	Bihar and Bengal	43	...
3.	Shwebo, Yeu and Katha Districts, Upper Burma	61	...
4 & 5.	Bihar	68	...
6.	Assam	74	...
7.	Mergui, Amherst and Shwegyin Districts, Lower Burma	76	...
12.	Magwe and Myingyan Districts, Upper Burma	79	...
Det.	Garhwal District, North-Western Provinces	82	...
„	Orissa	86	...
	Traverse Surveys.		
9.	Central Provinces	90	...

No. of Party.		Page Report.	Page Appendix.
	Geodetic.		
22.	Latitude Operations	93	x
23.	Ditto ditto	93	xxv
25.	Tidal ditto Levelling ditto	94	xxviii
	Geographical Surveys.		
11.	Upper Burma	98	...
21.	Ditto	100	lxv
	Tabular Statements.		
	Outturn of work of the Field Parties	104 & 105	...
	Cost-rates of ditto ditto	106 & 107	...
	Particulars of Cadastral Surveys completed in 1893-94	108	...

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

	Page Report.	Page Appendix.
Head-Quarters Offices, Calcutta	109	...
Superintendence, Correspondence and Accounts	109	...
Drawing Office	110	lxxiii
Bengal Provincial Drawing Office	112	...
Engraving Office	114	lxxxvii
Calcutta City Survey Office	115	...
Photographic and Lithographic Office	116	lxxxix
Map Record and Issue Office	119	...
Mathematical Instrument Office	120	xcviii
Trigonometrical Branch Office, Dehra Dun	122	cvii
Drawing Office, Simla	125	...
Forest Survey Branch Office, Dehra Dun	126	...
List of maps published during the year	128	...

APPENDIX.

EXTRACTS FROM REPORTS BY EXECUTIVE OFFICERS.

No. of Party.		Page
24.	Burma and the Indus Delta coast triangulation	i & ii
15.	Notes on the Antiquities, Ethnography and History of Las Bela and Makran	iii
22.	Latitude Operations	x
23.	Ditto ditto	xxv
25.	Tidal and Levelling Operations	xxviii
21.	Chin-Manipur Boundary Delimitation	lxv
„	Southern Shan States	lxx
	Drawing Office, Calcutta	lxxiii
	Engraving Office, Calcutta	lxxxvii
	Photographic and Lithographic Office, Calcutta	lxxxix
	Mathematical Instrument Office, Calcutta	xcvii
	Trigonometrical Branch Office, Dehra Dun	cvii

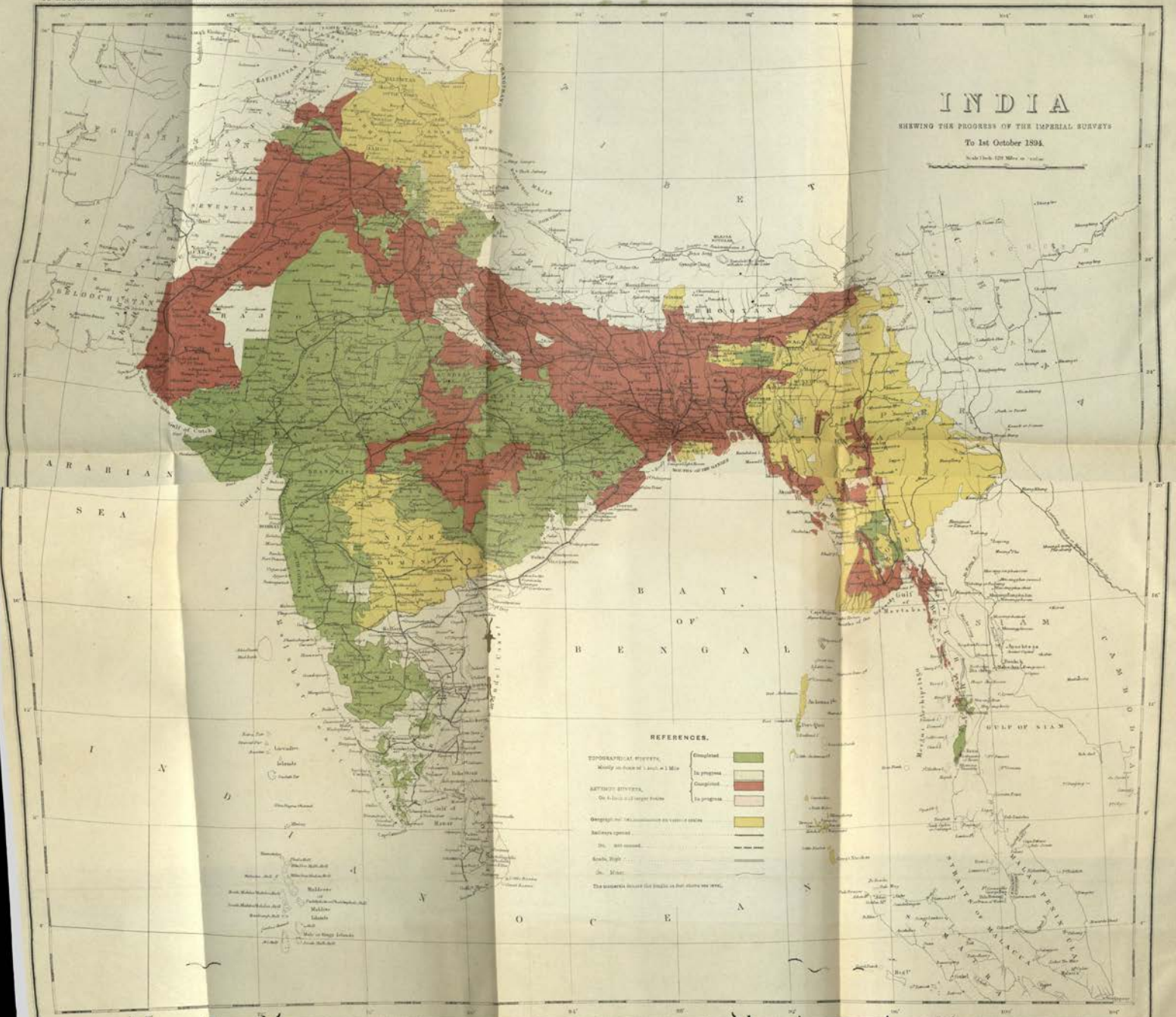
ILLUSTRATIONS.

PHOTO-ETCHINGS.

	TO FACE PAGE
Tomb of Salim Chisti, Fatehpur Sikri, near Agra	Frontispiece
In the City of Palaces	118

MAPS.

	TO FACE PAGE
India, showing progress of Imperial Surveys to 1st October 1894	1
Index Chart to the Great Trigonometrical Survey of India	*ib.*
Index to the Trigonometrical Survey in Upper Burma	19
„ „ Topographical Survey in Southern Maratha Country	20
„ „ „ „ in the Himalayas	24
„ „ „ „ in Aden	26
„ „ „ „ of the Indus River	27
„ „ Forest Survey in Nimar District	29
„ „ „ „ in Betul District	30
„ „ „ „ in Bombay (N. and C. Circles)	31
„ „ „ „ in Bombay (S. Circle)	32
„ „ „ „ in Madras, Madura District	34
„ „ „ „ in Madras, Salem District	*ib.*
„ „ „ „ in Madras, N. Arcot District	*ib.*
„ „ „ „ in Lower Burma	36
„ „ „ „ in Raipur District	38
„ „ „ „ in Narsinghpur District	39
„ „ „ „ in Balaghat District	*ib.*
„ „ „ „ in Nagpur, Seoni and Chhindwara Districts	*ib.*
„ „ „ „ in Bashahr State	40
„ „ „ „ in the Kheri and Pilibhit Districts	41
„ „ „ „ in the Pyinmana District	42
„ „ Cadastral Survey in Saran District	43
„ „ „ „ in Champaran District	45
„ „ „ „ in Gaya District	49
„ „ „ „ in Tippera District	52
„ „ „ „ in Palamau District	54
„ „ „ „ in Bogra District	56
„ „ „ „ in Hooghly District	57
„ „ „ „ in Sagaing, Shwebo etc., Districts	61
„ „ „ „ in Muzaffarpur District	68
„ „ „ „ in Darbhanga District	72
„ „ „ „ in Cachar District	74
„ „ „ „ in Amherst District	76
„ „ „ „ in Mergui District	77
„ „ „ „ in Shwegyin District	78
„ „ „ „ in Minbu and Magwe Districts	80
„ „ „ „ in Garhwal District	83
„ „ „ „ in Cuttack and Puri Districts	87
„ „ „ „ in Balasore District	88
„ „ Traverse Survey in Bilaspur District	90
„ „ „ „ in Sambalpur District	91
„ „ „ „ in Balaghat District	*ib.*
„ „ „ „ in Chanda District	*ib.*
„ „ Geographical Survey in Upper Burma	98
„ „ Topographical Survey in Upper Burma and the Shan States	100
„ „ Indian Atlas showing sheets published to 1st October 1894	114
„ „ „ „ showing work in hand on 1st October 1894	*ib.*



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Published under the direction of Colonel H. H. Thuillier, R.E.C.I.E., R.E., Surveyor General of India, March 1895.

Litho. S. I. Calcutta.

No. 380-S. 95.

INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
BAY OF BENGAL
ARABIAN SEA
CEYLON
REFERENCE

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1893-94.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations of the department that are now reported on are for the survey year ending 30th September 1894.

2. The general administration of the department and the superintendence of the Topographical Branch remained in the hands of Colonel H. R. Thuillier, R.E., Surveyor-General of India, throughout the year. The direct supervision of the Revenue Branch and of the Bengal Survey Branch has continued in the hands of Colonel C. Strahan, R.E., Deputy Surveyor-General, and Colonel J. E. Sandeman, S.C., Director of Bengal Surveys, except for a period of about three months during the recess season, when both these officers were absent on privilege leave, and during that time Colonel W. H. Wilkins, S.C., conducted the duties of both posts. Colonel G. Strahan, R.E., Deputy Surveyor-General, continued to superintend the Trigonometrical Branch until the 30th April 1894, when he retired from the department. This second post of Deputy Surveyor-General was then abolished, and in place thereof an officer of junior rank has been appointed in charge of the trigonometrical operations and of the allied head-quarters office at Dehra with the title of Superintendent, Trigonometrical Surveys. Major St. G. C. Gore, R.E., Deputy Superintendent, 1st grade, was selected for this post, and has conducted the duties from the 1st May 1894.

Inspection Tours of the Administrative Officers.

3. The Surveyor-General left Calcutta on the 7th October 1893 for Dehra Dun, and returned on the 28th idem, during which time he inspected the Trigonometrical Branch offices, and the office of the Forest Survey Branch, which is under the direction of the Inspector-General of Forests. On the 1st May 1894 he proceeded to Simla under the orders of the Government of India to be in personal communication with them for the arrangement of the programme of field operations and various other important matters, and he returned to Calcutta on the 19th July 1894. While at Simla he inspected the Survey offices located there, *viz.*, the Drawing office of the North-West Trans-Frontier Surveys and No. 18 (Himalaya) Party. Colonel Thuillier left Calcutta again on the 27th August 1894 to inspect the field parties located in the Madras and Bombay Presidencies. At Bangalore he inspected the offices of Nos. 11, 19, 20 and 21 Parties, and at Poona those of Nos. 10, 17 and 25 Parties. He returned to Calcutta on the 21st September and on the 29th idem proceeded to Dehra Dun, where he inspected the Trigonometrical Branch offices and the office of the Forest Survey Branch.

4. The Deputy Surveyor-General in charge of the Revenue Branch proceeded to Kamptee in the Central Provinces in October 1893, to visit No. 9 Party; he inspected the recess office and arranged with the executive officer a programme for the field season, to complete the work required in the Central Provinces. As there was some doubt as to the possibility of this being accomplished, the Deputy Superintendent was directed to consult the Commissioner of Agriculture as to which portions should be taken up first, so as to ensure the completion of the most important work. After leaving the Central Provinces the Deputy Surveyor-General proceeded to Naini Tal to inspect the Garhwal detachment; he examined the maps of the previous season and discussed the programme for the ensuing season, which was to complete the cadastral survey of all the more accessible parts of the district and all that was required.

In January 1894, Colonel C. Strahan again proceeded to the Central Provinces and inspected in the field two out of the three camps of No. 9 Party. He thence went on to the Belgaum district in Bombay to inspect No. 10 Party, and marched for 5 days through the country under survey, examining the work of such sub-surveyors as were met with.

The Deputy Surveyor-General visited the forest and all the cadastral survey parties in Burma during March and April 1894. In Lower Burma, No. 7 Party, whose work lay mainly in the Amherst district, was first inspected, two of the field camps being visited, the one at Amherst itself and the other at Pa-an on the Salween river. The forest survey party (No. 20), whose head-quarters were at Toungoo, was then visited, and after an inspection of the office at that place, a tour was made into the forests under survey, and the surveyors whilst actually at work in the field were visited and their sheets examined.

In Upper Burma, No. 3 Party was first inspected. After an examination of the head-quarters office at Mandalay, Colonel Strahan, accompanied by Mr. Scott, the executive officer, made a tour through Shwebo to Kawlin, where a halt was made to see the work in progress in Wuntho; thence he went to Katha, where Lieutenant Burn, the officer in charge of the triangulation party in Upper Burma, was met with. From Katha he proceeded to Letkobyin, the country around which was being topographically surveyed to assist in the search for coal in that neighbourhood. He then returned to Mandalay where he met Captain Longe, R.E., in charge of No. 21 Party, who had been demarcating and surveying the boundary between Manipur and the Chin Hills, and whose maps he examined. Finally, No. 12 (cadastral) Party was inspected at Magwe, and the Commissioner of the Division was visited at Minbu, where the progress of the work, both past and future, was discussed with him.

During his stay in Rangoon, Colonel Strahan visited the Chief and the Financial Commissioners and consulted them regarding the programme of cadastral work in Upper Burma during 1894-95. It was then decided that after the recess season of 1895, one cadastral party would suffice for Upper Burma and that No. 12 Party should be transferred to India, as the progress made in the survey had been so rapid that it was impossible for the settlement operations to keep pace with it.

In May 1894, the Deputy Surveyor-General proceeded to Pachmarhi in the Central Provinces in order to consult the Local Government on the advisability of retaining No. 9 Party for yet another year, as it had been impossible to complete the entire programme allotted for the field season of 1893-94. It was ascertained that there was other additional work required as well, which would be sufficient to keep the party profitably employed for another year, and it was then decided that the sanction of the Government of India should be asked for its retention until October 1895.

5. Colonel Sandeman, Director of Bengal Surveys, left Calcutta on the 23rd October 1893 for a tour of inspection in Bihar. He proceeded first to Gaya, and remained in that district inspecting the work in progress until the 26th, when he went on to Motihari where the camps of the Champaran cadastral and traverse sections were inspected. On the 28th October he proceeded to Muzaffarpur, where he was engaged in inspecting the two cadastral camps and work in the field until the middle of November. On the 17th November, Colonel Sandeman left for Sonepur, where several meetings were held, at which the Director of Land Records, the Bihar Settlement Officers and the Secretary of

the Indian Planters' Association were present. On the 27th November he returned to Muzaffarpur and from the 30th November to the 5th December was engaged in inspecting the two cadastral camps in that district. On the 5th he returned to Calcutta, where some of the difficulties of the work were explained to His Honour the Lieutenant-Governor. On the 13th December the Director left Calcutta again and was engaged on inspection duties in Muzaffarpur and Champaran until the 27th, when he returned to Calcutta to attend a conference on the maintenance of land records which sat daily until the 6th January 1894. On the 10th January 1894, he proceeded to Gaya, where he inspected the cadastral camp and the work in the field.

On the 16th January, Colonel Sandeman marched for Aurungabad, where he arrived on the 21st and met the Collector with whom survey matters were discussed. On the 23rd January he left for Palamau, and from the 24th to 27th idem was engaged in inspecting the field work in that district, in company with the Deputy Commissioner. On the 28th idem he returned to Gaya and joined the Survey camp at Shergotty, and on the 9th February he left Gaya for Muzaffarpur and was engaged in inspecting the cadastral and *khanapuri* camps in the field until the 15th idem. On the 16th February, he proceeded to meet the Lieutenant-Governor, with whom he remained until the 20th during His Honour's inspection of the survey operations in Bihar. On the 27th February, the Director proceeded to Saran and was occupied until the 6th March in inspecting the offices of the traverse and cadastral camps, and the work in the field in that district.

On the 10th March, Colonel Sandeman returned to Calcutta, and on the 13th idem proceeded to Balasore and was engaged in that district until the 22nd, inspecting the Orissa survey office and checking the work in the field, and returned to Calcutta on the 26th March.

On the 7th April, he left Calcutta for Comilla to inspect the office of the Tippera survey, and there discussed matters with the Collector and Mr. MacMinn, the Manager of the Maharaja's estates which were under survey. On the 11th, he arrived at the survey camp at Chauddagram, and was engaged until the 15th inspecting the field and office work, returning to Calcutta again on the 18th.

On the 21st April, Colonel Sandeman proceeded once more to Muzaffarpur, under the orders of the Lieutenant-Governor, to arrange for the recording of rents, and after discussing with the Settlement Officers the best method of making rent entries, communicated the necessary orders to the camp officer. On the 26th April, the Director inspected and tested the work of the Rajapur drainage survey, and on the 29th and 30th idem was engaged in testing the Jaipur estates survey in the Bogra district.

On the 7th July, Colonel Sandeman proceeded to Muzaffarpur and was occupied in inspecting the cadastral survey office there until the 10th idem. On the 12th he inspected the Patna College survey school, and from the 13th to 20th held an inspection of the four cadastral survey camps in their recess quarters at Dinapur. On the 21st July he proceeded to Lucknow by special permission to meet His Honour the Lieutenant-Governor of the North-Western Provinces to advise in the matter of settlement surveys for that province, and on the 26th July he proceeded to Mussooree to inspect the traverse sections of the Bihar survey parties which were recessing there.

6. The Superintendent, Trigonometrical Surveys, duly inspected, from time to time, the recess offices of the parties under his immediate superintendence, which are located at Mussooree, near his head-quarters, *viz.*, Nos. 14, 22, 23 and 24 Parties.

FIELD PARTIES.

7. The field operations of the year under report were carried on by 20 parties (of which two were double parties), and 4 small detachments. Of these, one party was employed on trigonometrical surveys; three parties and two detachments on topographical surveys; four parties on forest surveys; six parties and two detachments on cadastral surveys; one party on traverse surveys; three parties on scientific operations; and two parties on geographical surveys. Besides the above, the small detachments of the Forest Survey Branch (included in this report for the first time) have been employed on forest surveys.

The following tabular statement shows collectively the whole of these operations, grouped according to the scope and nature of the work on which the parties were severally employed :—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Burma . . .	19	Lieutenant J. M. Burn, R.E.	.....	Supt. Trig.
	Topographical Surveys.				
10	Bombay . . .	20	Major J. R. Hobday, S. C. Lieutenant H. A. D. Fraser, R.E.	2″=1 mile for reduction to half scale.	D. S. G. Rev.
15	Baluchistan . . .	21	Colonel T. H. Holdich, C.B., C.I.E., R.E.	2″=1 mile, 1″=1 mile, ½″=1 mile, ¼″=1 mile and ⅛″=mile for reproduction.	Ditto, Topo.
18	Himalayas . . .	23	Major St. G. C. Gore, R.E. Major R. A. Wahab, R.E. .	4″=1 mile for reproduction and reduction to half scale, and 2″=1 mile for reproduction.	Supt. Trig.
Det.	Aden Peninsula . .	25	Mr. G. P. Tate . . .	8″= mile and ½″=1 mile for reproduction.	D. S. G. Topo.
Det.	Indus River . . .	27	Mr. H. E. T. Keelan . .	1″=1 mile for reproduction.	Ditto Rev.
	Forest Surveys.				
14	Central Provinces. .	28	Colonel J. R. Wilmer, S. C. Captain W. J. Bythell, R.E.	4″=1 mile for reproduction.	Supt. Trig.
17	Bombay . . .	31	Colonel H. S. Hutchinson, S.C. Major J. R. Hobday, S.C. .	16″=1 mile, 8″=1 mile and 4″=1 mile for reproduction.	D. S. G. Topo.
19	Madras . . .	34	Major R. A. Wahab, R.E. . Captain H. M. Jackson, R.E.	4″=1 mile, for reproduction.	Ditto Topo.
20	Burma . . .	35	Mr. G. H. Cooke . .	4″=1 mile and 2″=1 mile for reproduction.	Ditto Rev.
Forest Survey Branch.	Central Provinces. .	38	Mr. W. H. Reynolds. .	16″=1 mile and 4″=1 mile for reproduction.	I. G. Forests.
	Punjab . . .	40	Ditto . .	4″=1 mile and 1″=1 mile for reproduction.	Ditto.
	Oudh	40	Ditto . .	4″=1 mile for reproduction.	Ditto.
	Burma . . .	41	Ditto . .	4″=1 mile for reproduction.	Ditto.
	Cadastral Surveys.				
2 & 8	Bihar and Bengal .	43	Captain J. M. Fleming, S.C. Lieutenant R. T. Crichton, S.C.	16″=1 mile for production.	Director, Bengal Surveys.
3	Upper Burma . .	61	Mr. G. B. Scott . . .	16″=1 mile and 2″=1 mile for reproduction.	D. S. G. Rev.
4 & 5	Bihar	68	Captain G. B. Hodgson, S.C.	16″=1 mile for reproduction.	Director, Bengal Surveys.
6	Assam	74	Mr. E. C. Barrett . .	16″=1 mile for reproduction.	D. S. G. Rev.
7	Lower Burma . .	76	Mr. C. Wood . . .	16″=1 mile, 2″=1 mile, and 1″=1 mile for reproduction.	Ditto Rev.
12	Upper Burma . .	79	Mr. A. E. Spring . . Mr. H. R. Littlewood . .	16″=1 mile for reproduction.	Ditto Rev.
Det.	Garhwal . . .	82	Mr. T. F. Freeman . .	32″=1 mile for reproduction.	Ditto Rev.
Det.	Orissa	86	Mr. R. C. D. Ewing . .	16=1 mile for reproduction.	Director, Bengal Surveys.
	Traverse Surveys.				
9	Central Provinces .	90	Mr. E. J. Jackson . .	16″=1 mile (skeleton plots).	D. S. G. Rev.
	Geodetic.				
22	India	92	Captain S. G. Burrard, R.E.	.....	Supt. Trig.
23	India	93	Lieutenant G. P. Lenox-Conyngham, R.E.	.....	Do. Trig.
	Tidal and Levelling Operations.				
25	India	94	Lieut. Colonel J. Hill, R.E. .	.....	D. S. G. Topo.
	Geographical Surveys.				
11	Upper Burma . .	98	Colonel R. G. Woodthorpe, C.B., R.E.	¼″=1 mile . . .	Ditto Topo.
21	Ditto . .	100	Captain F. B. Longe, R. E. .	1″=1 mile and ¼″=1 mile.	Ditto Topo.

OUT-TURN.

8. During the year under report the aggregate area surveyed on all scales amounts to 1,27,477 square miles. This area is exclusive of that embraced by the traverse operations in the Central Provinces, carried on for the purpose of furnishing a basis for field surveys under the Settlement Department, and of the skeleton survey of village boundaries in Bengal, which together amount to 3,572 square miles.

The operations of the various field parties will be found summarised in the following paragraphs, in the order in which they appear in the foregoing statement. A detailed report on the operations of each party for the year under review is given in Part II.

TRIGONOMETRICAL SURVEYS.

9. The principal triangulation in Upper Burma, on the meridian of 96° 30′ E. longitude, was extended northwards over a direct distance of 90 miles, embracing an area of 1,480 square miles, comprising three quadrilateral figures formed by eight stations, and reaching the parallel of 24° 40′ N. latitude. Astronomical azimuths were observed at two stations.

The fixing of beacons at convenient intervals along the mouth of the Indus river was undertaken to furnish a basis for the operations of the Marine Survey Department. A secondary series of triangles, comprising 26 stations of observation, was carried over a distance of 70 miles along the coast, from which the positions of 17 beacons have been fixed. Thirteen more beacons were erected, the positions of which will be obtained during the ensuing season, and this will complete the work required.

TOPOGRAPHICAL SURVEYS.

10. As in the two preceding years, three parties and two detachments have been again engaged on topographical operations. Nos. 10, 15 and 18 Parties continued the topographical surveys on various scales in the Bombay Presidency, in Baluchistan, and in the Himalayas, respectively; the detachment organized in the preceding year for the survey of the Indus river in Sind continued its operations, and a second detachment was formed for the survey of the Aden Peninsula, and to complete the survey of the portion of the Yafi'i country which was not included in the operations carried out in Arabia in 1891-92.

11. In addition to the topographical work executed by these parties, small areas were topographically surveyed by the cadastral parties in the Shwebo and Amherst districts for special purposes, and by the Forest Survey Branch in the Bashahr State. The topographical survey of Upper Burma on the 1-inch scale was commenced during the year by a detachment of No. 21 Party, the preliminary geographical survey of that province having been practically finished.

12. The areas topographically surveyed on various scales during the year amount to 16,072 square miles, against 10,215 square miles executed in the previous year.

The total is made up as follows:—

7,662	square	miles	surveyed	on	the	½	inch scale.
3,440	,,	,,	,,	,,	1	,,	,,
4,552	,,	,,	,,	,,	2	,,	,,
379	,,	,,	,,	,,	4	,,	,,
39	,,	,,	,,	,,	8	,,	,,

FOREST SURVEYS.

13. Forest survey operations were continued by the four parties previously employed on this class of surveys, in the Central Provinces, the Bombay and Madras Presidencies and in Lower Burma; and a further small area of forest lands was surveyed by the party working in the Himalayas.

14. In the Central Provinces, the detail survey of the forests in the Nimar district was continued, and an area of 565 square miles was completed on the

4-inch scale; besides this a large area of advance triangulation was effected in the Nimar and Betul districts. As usual, the classification of the forest growth and soils was carried out over the area surveyed in detail. The out-turn of detail survey is less by 63 square miles than that of the previous year, which is chiefly owing to the more difficult nature of the country operated in and to the prevalence of sickness among the surveyors, but the out-turn of work is quite satisfactory, considering that the field operations are necessarily restricted to a period of about four months only, owing to the unhealthy character of the tracts under survey. The cost-rate of the survey has been further reduced this year by over 10 per cent.

15. In the Bombay Presidency, work was carried on in the Northern, Central and Southern Forest Circles, and comprised surveys on the 16-inch scale of *babul* (acacia arabica) reserves in the Poona, Ahmednagar and Sholapur districts; on the 8-inch scale of teak reserves in the Poona, Ahmednagar, Thana and Kolaba districts; and on the 4-inch scale of ordinary forest reserves in the North Kanara and Poona districts. The total area surveyed amounts to 489 square miles, or 63 square miles in excess of the out-turn of the preceding year. The cost-rates per square mile of the surveys on each scale compare favourably with those of the previous year, and during the past three years have shown a steady annual diminution.

16. In the Madras Presidency, the survey of forest reserves on the 4-inch scale was continued in the Madura, Salem and North Arcot districts, and an area of 881 square miles of detail survey was effected during the year, or 93 square miles more than the out-turn of last year. The cost-rate of the survey again shows a diminution, being R72-12 per square mile for all the operations, which is R5-6 less than that of last year.

17. In Lower Burma, the survey on the 4-inch scale of forest reserves in the Hanthawaddy and Toungoo districts was carried on, the intermediate unreserved tracts being surveyed, as before, on the 2-inch scale. The area completed amounts to 426 square miles, which is 81 square miles in excess of last year's out-turn. The cost-rates of these operations have been somewhat reduced during the year under report, though they are still high as compared with those of similar work in India. The causes for the disparity are explained in the detailed account of the operations in Part II.

18. In the Himalayas an area of 161 square miles of forest land was surveyed on the 4-inch scale by No. 18 Party, in addition to its ordinary operations.

19. The operations of the Forest Survey Branch, which are incorporated in this report for the first time, are under the administration of the Inspector General of Forests, and under the superintendence of Mr. W. H. Reynolds, Deputy Superintendent. The officers are now included in the cadres of the Survey Department, and the establishment is organized into small detachments for taking up local forest surveys of a small and scattered nature for which the regular parties of the Imperial Department are too large.

The operations were carried on in several districts of the Central Provinces, in the Bashahr State, in the Kheri and Gonda districts in Oudh, and in the Salween and Pyinmana forest divisions in Lower and Upper Burma, respectively.

The aggregate forest area surveyed by the various detachments amounts to 1,433 square miles, of which 111 square miles of exterior forest boundaries were done on the 16-inch scale and 1,322 square miles of forest reserves on the 4-inch scale. In addition, the detachment in Bashahr surveyed an area of 287 square miles on the 1-inch scale of non-forest lands for the purpose of completing the topographical survey of that State. This area has been included in the out-turn under the head of Topographical Surveys.

For all the areas surveyed on the 4-inch scale a record was prepared during the progress of the survey, illustrating the distribution of forests; and for the forests in the Central Provinces the classification of soils was also recorded.

The cost-rates of the various forest surveys executed by the Forest Survey Branch are considerably lower than those of the Imperial survey parties. This is entirely due to the difference in the organization of the two establishments, and to the very limited European supervision which is employed in the former. In some of the detachments the supervision of the professional work was entrusted entirely to low-paid natives, which cannot be considered a sufficient safe-guard for obtaining accurate work.

20. The total out-turn of forest surveys executed on various scales during the year amounts to 3,955 square miles, of which 1,433 square miles was surveyed by the Forest Survey Branch. The area surveyed by the Imperial survey parties, *viz.*, 2,522 square miles, is 352 square miles in excess of the out-turn of the previous year by the same parties.

The areas on the different scales are as follows:—

144	square	miles	surveyed	on	the	2-inch	scale.
3,413	"	"	"	"	4	"	"
222	"	"	"	"	8	"	"
176	"	"	"	"	16	"	"

CADASTRAL SURVEYS.

21. The number of parties engaged on cadastral operations during the year has been as follows:—Two double parties and one detachment in Bengal; three parties in Burma; one party in Assam; and a detachment in the North-Western Provinces.

22. In the Bengal Province, the parties which are under the administration of the Bengal Government and the superintendence of Colonel Sandeman, Director of Bengal Surveys, were engaged as before in the cadastral survey and preparation of the record of rights in temporarily settled tracts and Government estates, and in private estates. During the year the principal operations have been carried on in the districts of Muzaffarpur, Champaran and Saran in North Bihar; in the Tikari estate in Gaya; in the Government estate in Palamau; and in the districts of Tippera and Balasore in which the cadastral survey work has been completed.

23. The following is a summary of the progress of work in each district in which the larger surveys were carried on.

In Muzaffarpur the area cadastrally surveyed during the year amounted to 979 square miles and that of the record-writing to 788 square miles. The cost-rates per square mile for these operations are ₹68 and ₹78, respectively. The traverse survey in this district had been completed during the previous year, in which also an area of 529 square miles was cadastrally surveyed, bringing the total of survey to 1,508 square miles, out of a total area to be dealt with of 3,000 square miles, including the 500 square miles which were surveyed experimentally in 1885-86.

In the Champaran district, the area of which is estimated at 3,531 square miles, the traverse survey was extended during the year over an area of 1,320 square miles, bringing the total of traverse work to 2,425 square miles. The season's cadastral survey covered an area of 517 square miles, which, with that done in the previous season, makes a total of 933 square miles of field survey. The record-writing completed in the previous year covered an area of 320 square miles; that of the year under report amounted to 599 square miles or a total of 919 square miles. The cost-rates of these operations for 1893-94 are, traversing ₹38, cadastral survey ₹75, and record-writing ₹54.

In the Saran district the traverse survey effected during the year under report covered an area of 932 square miles, and in the previous year the out-turn was 894 square miles or a total to the end of 1893-94 of 1,826 square miles. The cadastral operations were commenced during this year, and the out-turn of survey was 549 square miles, and of record-writing 527 square miles. The cost-rates per square mile of the year's operations are, for traversing ₹37, for cadastral survey ₹70, and for record-writing ₹50.

In the Orissa division, the survey and record-writing of the temporarily settled lands in the district of Puri, and also in Cuttack with the exception of the unirrigated portion of killa Aul, had been completed in the previous year. In the Balasore district, an area of 1,084 square miles had been cadastrally surveyed in 1882-83, and this work was continued during the year under report, when an area of 649 square miles was completed, and the records appertaining thereto were written. The cost-rates per square mile of the season's work are, for cadastral surveys ₹75 and for record-writing ₹70. The survey of all the temporarily settled areas in the Orissa division has now been completed with the exception of 148 villages in killa Aul, which will be undertaken during the present season of 1894-95.

The survey and record-writing of the Palamau Government estate in the Chota Nagpur division was commenced during the year. The total area of the estate was estimated to be 428 square miles, and the cultivated area therein, of which a survey was required, was estimated to be about 178 square miles, but this has been found to be much below the truth. The traverse operations have already covered an area of 318 square miles, and the cadastral survey with records has been carried out over 131 square miles. It is now estimated that 154 square miles still remain for survey. The cost-rates per square mile of the different operations are, traverse ₹24, cadastral survey ₹94 and record-writing ₹74.

The survey of the Jaipur Government estates in district Bogra, embracing an area of 55 square miles, which had been commenced in the previous season, when an area of 13 square miles was surveyed, was continued and brought to a conclusion during the year under report. The out-turn of cadastral survey was 42 square miles, and the records were written of the entire area of 55 square miles. The cost-rate per square mile of these operations, excluding the traverse which was done the year before, amounted to ₹138.

The survey of the estates of the Maharaja of Hill Tippera known by the name of Chakla Roshnabad, in the districts of Tippera and Noakhali, was continued and has been completed. The out-turn of cadastral survey for the year was 261 square miles and of the record-writing 348 square miles; the cost-rates per square mile being ₹151 and ₹102, respectively. The total area of these estates is 559 square miles, and the cost of the survey has been enhanced by the operations being prolonged over two years at the special request of the Maharaja. The survey of the Gangamandal estate in Tippera, with an area of 1·16 square miles, was also taken up by the party employed on the Chakla Roshnabad estates. The traverse survey was completed of the three villages comprised therein, and the cadastral survey and records were completed in two of the villages, the survey of the third having been suspended by an order of the Collector of the district.

In the Tikari Ward's estate, district Gaya, the total area to be dealt with according to the latest information is 711 square miles comprised in 936 scattered villages. During 1892-93, the traverse survey was commenced and an area of 217 square miles was prepared. During 1893-94 the traverse work was extended over a further area of 334 square miles, and an area of 408 square miles was cadastrally surveyed. The records were written for 458 villages covering an area of 332 square miles. The cost-rates per square mile for these operations were for traverse ₹43, for cadastral survey ₹86 and for record-writing ₹61. The revision of the 32-inch scale maps and records of the Tikari villages included in the irrigation survey of 1875-76 was also undertaken, and the mapping of 63 square miles and records of 27 square miles were revised. A boundary survey on the 16-inch scale, of *mukarrari* villages (held on fixed and permanent lease) in this estate was also commenced, and an area of 147 square miles, comprising the boundaries of 224 villages, was so surveyed.

In the Burdwan Raj estate in the Bankura district, the completion of the maps and professional records of the 4-inch scale boundary skeleton surveys which had been in progress for some years was accomplished. The cadastral survey and record-writing of 12 new *mahals* of this estate in the Burdwan and Hooghly districts, embracing an area of about 10 square miles, which had been omitted from the previous survey, was undertaken. The traverse and cadastral survey was completed, but the record-writing was not quite finished, an area of about 3 square miles remaining to be written.

The survey of the lands reclaimed under the Rajapur drainage scheme, which had been commenced in 1891-92, were completed during the season under report, when an area of 36 square miles was cadastrally surveyed and the record-writing for 106 villages covering an area of 57 square miles, was completed. The total drainage area that has been surveyed amounts to 83 square miles.

24. In the Burma Province, three parties were again engaged on cadastral operations this year; one in Lower Burma and two in Upper Burma. In the former, cadastral operations were continued by No. 7 Party in the districts of Mergui, Amherst and Shwegyin. The total area surveyed on the 16-inch scale amounted to 881 square miles which are distributed as follows; in Mergui 123, in Amherst 679 and in Shwegyin 79 square miles. Advance traverse survey

was carried on in Amherst and Shwegyin. The cost-rate of the cadastral survey in Mergui during the year under report is about 9 per cent. less than that of the previous year, while in Amherst and Shwegyin together the cost-rate of the traverse and cadastral operations is R213 per square mile, which is about the same as in last year. A survey of the tin mines in Maliwun and Bahuni, on the scale of 64 inches to the mile, and covering an area of 1½ square miles, was also carried out. In addition to the cadastral survey, an area of 221 square miles of intervening unculturable country was topographically surveyed on the 1-inch and 2-inch scales by this party to complete the topographical maps.

The survey of the cultivated lands in the Mergui district has now been completed. In Amherst, owing to the additional areas assigned for survey, referred to in last year's report, being larger than was estimated, there still remain about 550 square miles to be cadastrally surveyed; this area will be completed during season 1894-95. The number of Burmans and Karens employed during the year was 36, of whom 23 had been enlisted under Mr. Bridge's scheme, which is alluded to in last year's report. Their average out-turn of survey has improved this year, being six-sevenths of that of the Hindustanis, whereas last year it was only two-thirds. During the recess the revision survey of the preliminary sheets of the Rangoon town which was commenced last year was carried on and will be completed early in the recess season of 1895.

25. In Upper Burma, the work allotted to No. 3 Party was scattered over portions of six different districts and was of a varied nature. The main portion of it consisted in the cadastral survey on the scale of 16 inches to the mile of 630 square miles in Yeu, 226 square miles in Katha, and 820 square miles in Meiktila; in addition to this, small areas aggregating 282 square miles were cadastrally surveyed in the districts of Shwebo, Yamethin, and Upper Chindwin. The total out-turn of cadastral survey accomplished in these districts amounted to 1,958 square miles; the large area thus surveyed, which is nearly 200 square miles in excess of last year's out-turn, is owing to the entertainment of a large number of Burman field surveyors from the local Survey Department, who were employed in addition to the original establishment.

The cost of the above surveys varied considerably in the different districts according to the conditions met with. The average aggregate cost-rate of the traverse and cadastral survey amounted to three annas six pies per acre.

The cadastral survey in Katha was undertaken with a view to facilitate enquiries regarding tenants' rights, and in order to prevent a great loss of time and money the Deputy Superintendent in charge of the survey party directed the Burman field surveyors to mark off the holdings and to make a register of the tenants' names, which was duly carried out and made over to the special officer appointed to make the enquiries. This is the first time that any attempt at writing a record-of-rights has been made in Burma by the Survey Department, and it is satisfactory to note that it was pronounced to be on the whole very accurate. A similar record was written for the State lands surveyed in the Upper Chindwin district. Local labour was again extensively employed this year and the number of menials imported from India reduced. An attempt was made to induce more Burmans to join the party to learn surveying, and in the Yeu district 14 men joined the survey camp, remaining under training from one to four months.

In addition to the cadastral surveys, an area of 183 square miles of country was topographically surveyed on the 2-inch scale in the coal-bearing tract in the Shwebo district, while, as a preliminary to the survey of the gold-mining grants on the Katha district, traverses were run round the outer limits of one prospecting and four mining grants.

26. The second party in Upper Burma (No. 12 Party) continued the survey of the Magwe district and carried out the traverse and cadastral survey of certain islands in the Irrawaddy river situated in the Pakokku district. Advance traverse work was carried on in the Myingyan district. The total out-turn of the party amounted to 1,276 square miles of 16-inch survey, of which all but 26 square miles lay in the Magwe district. The cost-rates per square mile for the different classes of work are for the traverse survey and permanent marks R49 and for the cadastral survey R111, which on the aggregate is about R23 per square mile less than the rate of the previous year. The establishment of field surveyors consisted of 40 Burmans and 92 Hindustanis imported from India;

the work done by the former was good, but their progress was much slower, the average monthly out-turn being only three-fourths of that of the Hindustani. Local chainmen were again employed as much as possible this year and no difficulty was experienced in getting men to serve.

Nearly 900 square miles still remain for survey in the Magwe district, and this, with the continuation of traverse work in Myingyan, will form the programme for 1894-95. Owing to the large areas that have been annually accomplished by the two survey parties in Upper Burma, the survey work has got too far in advance of the settlement operations, and it has, therefore, been decided to withdraw No. 12 Party from Upper Burma in October 1895 and to continue the cadastral survey operations there with one party only.

27. In Assam, traverse and cadastral operations were carried on in the Cachar district, where 360 square miles of traverse and 150 square miles of detail survey were completed. The total area to be surveyed in this district amounts to only 1,100 or 1,200 square miles, about one-half of which comprises lands under grants. As the existing settlement does not expire until March 1898, there was no necessity for a speedy completion of the survey; hence it was arranged that it should extend over four seasons, and the programme for 1893-94 was accordingly laid down at 150 square miles of cadastral and about 400 square miles of traverse survey: this was adhered to. The cost-rate of the combined operations amounted to ₹177 per square mile, which is high, but this is due to the operations having been restricted to such a small area. The completion of the work a year earlier has since been decided on, so as to allow sufficient time for the completion of all papers connected with the new settlement before the existing settlement expires. The field to field survey was carried out for the first time in Assam exclusively by local and Bengali field surveyors, supervised by Bengali inspectors, but the latter proved to be lax in their duties, and it will be necessary to revert to Hindustani inspectors in future.

28. The detachment in the North-Western Provinces continued the cadastral survey of the Garhwal district and completed the cultivated portions which had been allotted for survey. The season's out-turn consisted of 261 square miles of cadastral survey on the 32-inch scale and it was mainly executed by local surveyors, whose work averaged that of the Hindustani *amins* both in quantity and in quality. In the course of the survey over 300 hill men have been trained and are now available for any other surveys which may be required in the Kumaun division. The cost-rate of the field operations in detail survey and record writing of the area surveyed this season is ₹99, as compared with ₹174 per square mile during 1892-93 and ₹183 the year before; this reduction is mainly due to the steadily increasing experience of the hill men, but much credit is also due to the good management of Mr. Freeman who has held charge of the detachment since October 1891. He has had unusual difficulties to contend with; the severity of the climate made the work very unpopular with men from the plains on whom he was dependent until he had trained hill men; the natives of the country objected to the survey and threw all kinds of obstacles in his way at first; and in addition he had to make arrangements for the importation of supplies for his men on account of local famine.

29. The areas of cadastral survey completed during the year in the different provinces are as follows:—

	Square miles.
Bengal	3,754
Burma	4,115
Assam	150
North-Western Provinces	261
TOTAL	8,280

This out-turn shows an increase of 525 square miles over that of the previous year, when the number of parties employed was the same.

TRAVERSE SURVEYS.

30. One party was again employed this year in the Central Provinces on traverse surveys, which are designed to furnish a skeleton basis for settlement surveys by local agency. The operations were continued in districts Bilaspur,

Sambalpur and Balaghat, and in the *zamindâri* villages of Chanda district. The areas traversed amounted to 845 square miles in Sambalpur, 1,500 square miles in Bilaspur, 176 square miles in Balaghat, and 956 square miles in Chanda, making a total of 3,397 square miles, of which skeleton plots on the 16-inch scale were supplied to the Settlement Department. This out-turn is considerably in excess of last year, and the cost-rate of the work has been reduced to R20 per square mile—results which must be considered very satisfactory.

It had been hoped that all the traverse survey required in the Central Provinces would have been completed, but this could not be accomplished, as the operations were seriously retarded in the early part of the field season by an abnormal amount of sickness, and the work in Chanda and Bilaspur remained incomplete. It has been ascertained that additional traverse work is also required to complete forest and *zamindâri* boundaries elsewhere, and it has been decided to retain the party in the Central Provinces for another year to complete all the work required.

31. In Bengal, the traverse survey of certain village boundaries was carried out in the Gaya and Shahabad districts, in which an area of 175 square miles was completed.

32. The areas which have been thus traversed during the year, in addition to the preliminary traversing connected with the cadastral surveys done by this department, are a follows:—

	Square miles.
Central Provinces	3,397
Bengal	175
TOTAL	3,572

SPECIAL OPERATIONS.

33. The two astronomical parties under Captain Burrard and Lieutenant Lenox-Conyngham resumed the latitude observations that were in progress last season. The former officer was employed on the Jodhpore Meridional Series, near the meridian of 72°, beginning with Bithnok in latitude 27° 53′ and ending with Dera Din Panah in latitude 30° 34′, and he completed observations at six stations besides those at Agra and Amritsar which were done at the commencement and close respectively of the field season. The latter officer was employed along the Bider Longitudinal Series, beginning at Bolarum longitude station, on the meridian of 78° 34′ and closing at Waltair longitude station, on the meridian of 83° 20′, having observed at seven stations in all.

A valuable note on local attraction in India, based on the data obtained by the trigonometrical survey, has been drawn up by Captain Burrard and will be found in the appendix to this report at page xiii.

34. The tidal operations have been continued as usual. Observations with the self-registering tide-gauges have been made at thirteen stations in India, Burma, the Persian Gulf, Ceylon, the Andaman Islands and Minicoy. The tidal observatories at Mergui and Bhavnagar were closed during the year, on the completion of the five years' observations. No new observatories were opened during the year, the resumption of tidal observations at Madras and the starting of new observatories at Diamond Island and Port Albert Victor having been delayed from various causes: observations at these three stations will commence early in the ensuing year. The tidal observatory at Bushire was destroyed by a cyclone in December 1893, but was re-erected on a secure foundation, and observations resumed in April 1894.

35. In connection with the tidal operations, spirit-levelling was carried on in a continuous line from Sakti station on the Bengal-Nagpur Railway, where the work closed at the end of season 1891-92, to Sambalpur, and thence along the proposed new line of railway to Kendrapara, near False Point, thus connecting Bombay by levelling with False Point and Calcutta. The total out-turn of these operations for the season amounts to 369½ miles of double levelling, fixing 355 permanent, 11 railway, 2 Public Works Department, 25 irrigation and 32 temporary bench-marks, and determining the values of two stations of the Great Trigonometrical Survey.

GEOGRAPHICAL SURVEYS AND RECONNAISANCES.

36. There has again been a large increase in the area geographically surveyed during the year, which is due to the very large extent of country embraced by the reconnaissance surveys in Persia and Arabia carried out by three native surveyors of No. 15 Party. The area mapped in Upper Burma is again smaller, owing to the fact that but little of the preliminary geographical survey remained to be done. The first survey of Upper Burma may now be considered as closed, as with the exception of the extreme northern part of the province where the country is not yet sufficiently settled to allow of survey parties entering, the topography is practically complete.

37. Of the two parties employed in Upper Burma, the area geographically surveyed by No. 11 Party on the $\frac{1}{4}$-inch scale amounted to 10,870 square miles, of which 7,880 square miles were mapped by the main body of the party in the Southern Shan States, 2,570 square miles by the detachment which was employed on the Anglo-Siam boundary, and 420 square miles by a native surveyor in the Karenni country. The area mapped by No. 21 Party on the $\frac{1}{4}$-inch scale amounted to 3,920 square miles, of which 2,550 square miles was mapped by a detachment working in the Chin-Manipur hills where the country is very difficult and intricate. The remaining area of 1,370 square miles was obtained by a native surveyor who accompanied an expedition to the Konke country.

38. The total areas mapped on the $\frac{1}{4}$-inch scale in Upper Burma amount to 14,790 square miles.

39. Of the geographical work done on the western frontier by No. 15 Party, by far the greater portion lay in Persia, where one surveyor alone effected a reconnaissance survey on the $\frac{1}{8}$-inch scale of 54,000 square miles, of which the greater part is country either not previously mapped or with nothing more than route traverses intersecting it. The reconnaissance of 10,090 square miles of country on the Persian coast was also carried out on the $\frac{1}{8}$-inch scale, and a further area of 12,000 square miles on the same scale was obtained by Imam Sharif, Khan Bahadur, while attached to an exploring party under Mr. Theodore Bent in Southern Arabia. Reconnaissance surveys on the $\frac{1}{4}$-inch scale were also carried on by this party in Gilgit, Kurram, and Zhob, amounting in area to 8,290 square miles.

40. The aggregate areas geographically surveyed during the year on the eastern and western frontiers amount to 99,170 square miles.

HEAD-QUARTER'S OFFICES.

41. The details of the work done in the various offices at the head-quarters are given in Part III of this report.

42. The offices located in Calcutta were, as usual, supervised by three Assistant Surveyor-Generals. The Drawing and Engraving Offices remained in the charge of Colonel W. H. Wilkins, S. C., except during the last three months of the year, when the charge was held temporarily by Mr. B. G. Gilbert-Cooper. Colonel J. Waterhouse, S. C., continued to superintend the Photographic and Lithographic Office until July, when he proceeded to England on special leave and the charge then devolved upon Mr. T. A. Pope for the remainder of the year. The charge of the Correspondence and Mathematical Instrument Offices remained in the hands of Colonel M. W. Rogers, R. E., throughout the year.

43. In the Drawing Office, the preparation of maps of Burma on various scales continued to be the principal work of the year. Besides a large number of sheets of the North-East and South-East Frontier series, a second edition of the map of Upper Burma on the 16-mile scale was in hand during the year, and was nearly ready for publication in two colours at its close. Compilations of the provincial maps of the Bombay and Madras Presidencies were completed and made over to the Engraving Office for engraving on copper. The third edition of the 32-mile map of India, which still awaits the orders of Government in respect of frontier boundaries, has been brought up to date, all available new material having been incorporated. The principal non-departmental

work undertaken has been the preparation of the maps for a new edition of the Statistical Atlas of India; and of nine statistical maps of India, on the 32-mile scale, for the Antwerp exhibition.

44. A drawing office for the preparation of topographical maps from the results of the cadastral surveys in progress in Bengal was organized at head-quarters during the year under the designation of the Bengal Provincial Drawing Office, in order to relieve the field parties of this work, as it was found that they were unable to cope with it. The maps dealt with during the year were those of Jalpaiguri, Orissa and Bihar. Those of Jalpaiguri had been chiefly compiled in the office of the party, and their completion and examination formed the greater part of the work of thenew office during the year. Satisfactory progress was made with the Orissa and Bihar mapping.

45. In the Engraving Office, the preparation of the quarter-sheets of the Atlas of India was steadily pushed on, eight new plates having been completed and published during the year and 40 others being in various stages of progress. Eight districts maps for administration reports were engraved and five more were in hand. Corrections to date were made to the six plates of the skeleton 32-mile map of India, while that on the 128-mile scale was still in progress. The 256-mile map of India, without hills, was completed and published. The plate of the 96-mile railway map of India was nearly completed. Of provincial maps, those of the Bombay and Madras Presidencies, of Gujarat, and of the North-Western Provinces and Oudh, on the 16-inch scale, were all in hand and made good progress; while a map of Bengal on the 80-mile scale was completely engraved and another on the 64-mile scale was in hand. The nine plates of the map of the city of Calcutta on the 16-inch scale were begun during the year and completed in outline, the lettering, ornamentation and shading of buildings was well advanced, and the whole map is expected to be ready for publication before the close of the ensuing year.

46. In the Calcutta City Survey Office, the 73 fair sheets, on the scale of 50 feet to the inch, the drawing of which was in hand at the commencement of the year, were all completed and sent to press by the 5th March 1894. The outstanding block maps which were under examination by the municipality, were all received back and finally sent to press before the end of August. All disputed boundaries were finally settled, and the whole work in connection with the city survey was brought to completion by the 31st August, when the office was broken up and the permanent members of the establishment were transferred to other field parties.

47. In the Photographic and Lithographic Office, the number of subjects dealt with has somewhat fallen off owing to the demands from other departments being smaller, but the number of printed impressions from zinc, stone, and type was greater even than in the year before, when the out-turn had reached the number of a million pulls. The total number of original maps and drawings received for reproduction was 7,076, of which 1,100 were departmental, 4,782 were cadastral maps of the North-Western Provinces, Assam and Burma, and 1,194 were miscellaneous subjects from other departments. The departmental work shows a large increase and the value of it has risen from ₹81,128 to ₹98,760, but on the other hand the extra-departmental work is much less and the value of it has decreased from about ₹91,118 to ₹71,141.

The out-turn of the lithographic and zincographic presses and machines was 1,039,071 pulls of maps, etc., which is an increase of 12,389 over the out-turn of the previous year. The work of the other presses, etc., comprised 1,564,453 impressions from type, 50,678 heliogravure prints and 4,013 other photographic prints, which also compares favourably with the former year's work. The total value of the work done was about ₹2,37,673.

The new publications of the year include a map of Indo-China, on the scale of 1 inch=32 miles, printed in two colours; 81 standard maps of the topographical and revenue surveys on various scales; maps of the Allahabad division and of districts Hooghly, Bhagalpur, Goalpara, Cachar, Nadia, Palamau, Tippera, and of Naga Hills and Ruby Mines (second editions), all on the quarter-inch scale; 55 sheets of the Madras Forest Surveys, and 38 of the Forest reserves in the Jalpaiguri district on the 4-inch scale. Of the Calcutta survey, on the 50-feet scale, 127 sheets were reproduced by photo-zincography and printed off and the work has since been completed. A second edition of the

plan of the Quetta civil station has been published; also plans of Tounggyi civil station and Kolhapur town and environs.

The publication of the third edition of the 32-mile map of India is still deferred for want of orders regarding frontier boundaries, but further additions have been made to it and all new material incorporated. The delay in the issue of this map is much to be deprecated as the lithographic stones cannot be further corrected, and it is therefore likely to be out of date before it is published. A new edition of the 24-mile map of Afghanistan, to be lithographed in three colours, has been taken in hand.

Among the extra departmental work may be mentioned 28 plates for the new edition of the Statistical Atlas of India; a geological map of Hazara prepared, but not printed off; several plans of the Gohna landslip; 115 plates illustrating the Mogul architecture of Fatehpur Sikri; also nine sheets of a plan of Georgetown, Penang, photo-zincographed for the Government of the Straits Settlements.

The heliogravure section has continued to make steady progress, though the out-turn of printed copies was not quite so large as in the previous year. Eighty-six plates were photo-etched; including 53 plates of the Bower manuscript, 12 plates illustrating the zoology of the R. I. M. S. "Investigator," 10 plates of coins for the Indian Museum, and 14 plates of the Technical Art Series. In the frontispiece of this report is a specimen of the heliogravure process, being an enlargement from a photographic negative of a view of the tomb of Salim Chisti at Fatepur Sikri, near Agra.

48. In the Map Record Office, the number of new maps and new editions of departmental subjects received during the year amounted to 5,234, of which 4,810 were cadastral maps. The total number of maps issued was 289,915, and their value ₹1,64,795. The issues show a decrease on those of the previous year of 33,348 in number, owing to the smaller demands both by Government officials and private individuals, but the value of the maps issued is ₹13,821 greater. The cash sales of maps amounted to ₹23,096, against ₹33,303 in the preceding year.

49. The demands on the Mathematical Instrument Office for the supply of scientific instruments has been considerably less this year than in the two preceding ones, but the out-turn of work accomplished in the workshop in repairs, etc., shows a small increase. The total number of instruments issued was 63,728, as compared with 100,827 in the last year. The value of the issues and repairs was ₹2,57,487, against ₹3,15,239 in the previous year.

During the year, 75,617 serviceable instruments valued at ₹4,24,529, and 5,977 repairable instruments valued at ₹76,899, have been received into store. The cash payments for supplies under the value of ₹50 have increased considerably, the receipts being ₹38,037, as compared with ₹28,186 in the previous year.

50. Considerable change has been made in the organization of the Trigonometrical Branch Office at Dehra Dun during the year. On the retirement of Colonel G. Strahan, R.E., the post of Deputy Surveyor-General, Trigonometrical Branch, was abolished, and a Deputy Superintendent, Major St. G. Gore, R.E., was appointed to the charge of the branch with the title of Superintendent, Trigonometrical Surveys. The office establishment was also re-organized with a view to largely increasing the strength of the Photo-zincographic Section, mainly at the expense of the Computing Section, in order to enable it to cope with the constantly increasing demands for the reproduction of maps.

During the year, the Computing Section resumed the computations for the synoptical volume of the North-East Longitudinal Series; a large amount of press copy was prepared and press proofs examined; a considerable amount of work was, as usual, done in connection with the reduction and publication of spirit-levelled heights, and a quantity of miscellaneous computations carried on. The field records of the Palwal town survey were reduced and plots supplied to the Deputy Commissioner of Gurgaon. The other sections of the office were fully occupied throughout the year, and it is satisfactory to note that the greater part of the arrears of maps awaiting publication have been cleared off.

51. The Simla Drawing Office has been principally engaged on the revision of the sheets of the North-West Trans-Frontier Series and the South-West

Asia Series, in many of which there have been considerable changes owing to recent surveys and reconnaissances. New editions of the maps of Turkestan and Baluchistan were completed, and a new map of Afghanistan on the 16-mile scale was commenced and very nearly completed.

52. The head-quarters office of the Forest Survey Branch at Dehra Dun is chiefly engaged in the maintenance of the Forest Department map records; on the final computations of the several field detachments, and on the drawing and compiling of special maps for the Forest Department. During the year the map records of the forest areas operated in have been brought up to date, and the tabulated statements connected therewith were fairly advanced towards completion. A catalogue of the maps in deposit in the office was also prepared. A considerable number of special maps and maps of tracts surveyed by the Forest Survey Branch were published, and various others were in different stages of completion at the close of the year. In addition, a large amount of miscellaneous work was performed, including the training of thirty men in forest survey work and drawing.

ESTABLISHMENT.

53. During the year the department has lost the services of four officers of the senior division.

Colonel G. Strahan, R. E., Deputy Surveyor-General, in charge Trigonometrical Branch, was superannuated on the 30th April 1894 after a service of 32 years in the department. His employment throughout has been on topographical and geodetic operations, in both of which sections he has rendered valuable services as an executive officer and in the latter as an administrative officer as well. During the last 5½ years of his service Colonel G. Strahan was Deputy Surveyor-General and superintended the Trigonometrical Branch, in which his high scientific attainments were of particular value, and his retirement is a loss to the department.

Colonel H. S. Hutchinson, S.C., Superintendent, 2nd grade, was killed by a wounded tiger on the 27th April 1894. He joined the department in 1867. His principal services therein have been in connection with revenue surveys, and latterly he was employed on topographical operations. In both branches he has rendered much useful work as an executive officer.

Captain C. F. Close, R.E., Officiating Deputy Superintendent, 2nd grade, reverted to military duty on the Imperial establishment on the 3rd December 1893, on the expiration of his first tour of service in India. He served in the Survey Department for four years and was employed chiefly on trigonometrical operations, in which he did good work.

Mr. H. R. Littlewood, Assistant Superintendent, 1st grade, died on the 9th August 1894, after a service of 34 years, the whole of which was spent in the Revenue Branch. Mr. Littlewood was originally appointed to the junior division, and was promoted to the senior division of the department in 1891. His principal services have been in connection with cadastral surveys in Burma, in which he has rendered very good service.

54. In the junior division five vacancies have occurred during the year—two by the superannuation of Messrs. W. Todd and A. M. Lawson; one by the death of Mr. A. Kitchen, and two by the deputation of officers to the Land Records Department, Burma.

RETROSPECT.

OPERATIONS FROM 1886 TO 1894.

55. As the report now submitted is the last record of the administration of Colonel H. R. Thuillier, R.E., a very brief review of the various field operations which have been carried out during the nine years in which that officer has held the appointment of Surveyor-General of India, may appropriately be included.

56. The areas of the different classes of survey which have been mapped by the field parties of the Survey of India Department during that period are as follows:—

CADASTRAL SURVEYS.

On the 16-inch and 32-inch scales.

	Square miles.
In North-Western Provinces	8,818
„ Assam	5,262
„ Bengal	15,170
„ Burma	17,905
„ Central Provinces	3,744
TOTAL	50,899

FOREST SURVEYS.

On the 4-inch and 8-inch scales.

	Square miles.
In India and Burma	15,077

TOPOGRAPHICAL SURVEYS.

On the $\frac{1}{2}$-inch, 1-inch and 2-inch scales.

	Square miles.
In India and Burma	121,388

GEOGRAPHICAL SURVEYS.

On the $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales.

	Square miles.
In Burma, North-Western Frontier, Persia and Arabia	656,854

The aggregate out-turn of surveys under the above heads for the period under review amounts to an area of 844,218 square miles, which is almost seven times more than the area of the British Isles.

The surveys of 17 cities, towns and cantonments have also been mapped on various large scales during the same period, of which the most important is that of the City of Calcutta, on the scale of 50 feet to the inch, a work of considerable magnitude.

57. In addition to the foregoing operations, there are two other classes of field work dealt with, *viz.*, traverse surveys and geodetic operations.

TRAVERSE SURVEYS.

These differ from the regular surveys in being merely a skeleton upon which a cadastral survey is built up. The traverses are measured and plotted by the Survey Department, but the details instead of being filled in by the same agency, are executed by local agency under the superintendence of the Provincial Settlement Departments. Of this class of survey, 93,694 square miles have been finished, principally in the Central Provinces.

GEODETIC OPERATIONS.

Under this heading are included triangulation (principal and secondary) as unconnected directly with map-making, astronomical operations, tidal and levelling work and observations of sun-spots with the photo-heliograph.

The principal triangulation has been confined to Upper Burma, for the main frame work originally designed as a geodetic basis for the survey of India proper had been previously completed. Secondary triangulation has been carried out in Upper Burma and Baluchistan, and also along certain parts of the coast of India as a basis for the Marine Survey. The areas that have been covered by these operations, during the past nine years are as follows :—

	Square miles.
Principal triangulation	9,145
Secondary do.	15,995
TOTAL . .	25,140

Astronomical latitude has been observed with the zenith sector at 49 stations of the Great Trigonometrical Survey and 29 arcs of longitude have been measured with the aid of the electric telegraph, which practically completes this class of work. The longitude operations are now being connected with Greenwich and the true longitude of India will be thus set at rest.

Tidal observations have been systematically continued at an average of 17 ports annually on the coasts of India, Ceylon, Burma, Andaman Islands Minicoy Island, on the Persian Gulf and at Aden. Observations at 19 new ports have been established during the period under review. The predicted times and heights of tides have been calculated for an average of 25 ports per annum, and these have been of special use for purposes of navigation, apart from their scientific value.

In connection with the tidal work, a double line of spirit levelling has been carried over 4,028 miles of road and railway in India and Burma. This will prove useful in harmonizing the levels that have been executed for irrigation and railway purposes by other departments, besides its immediate value for the rectification of trigonometrical heights.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL AND SECONDARY TRIANGULATION.

BURMA AND THE INDUS DELTA COAST.

No. 24 Party.

58. This party, under Lieutenant Burn, was divided into two sections, one working in Upper Burma and the other on the Indus delta coast.

Personnel.

Lieutenant J. M. Burn, R.E., Assistant Superintendent, 1st grade, in charge.
Lieutenant A. J. Pilcher, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. J. Hickie, Extra Assistant Superintendent, 5th grade.
Mr. P. F. Prunty, Extra Assistant Superintendent, 6th grade.

59. The former section, under the direct control of Lieutenant Burn, continued the principal triangulation in Upper Burma northward from the side Zintaung-Kyauktaung, up to which it had been carried in the previous season, and carried this triangulation practically right through the Katha district from south to north. It also executed some secondary triangulation, thereby fixing the positions of the important towns of Tigyaing and Katha, both on the Irrawaddy river, and also some points useful for topographical purposes.

60. The Indus delta coast section, under Mr. Prunty, was detailed to erect and fix the positions of beacons from Karachi to the Kori creek in Cutch, some 120 miles along the coast to the south-east, in order to furnish points at convenient intervals, as a basis for the coast survey to be undertaken by the Marine Survey Department.

61. The season's out-turn of the Upper Burma section is as follows:—Horizontal and vertical angles have been taken at 18 principal stations. The principal series was extended over a direct distance of 90 miles, embracing an area of 1,480 square miles. Horizontal and vertical angles have been taken at five secondary stations, the secondary series embracing an area of 740 square miles. Astronomical observations for azimuth were taken at two principal stations.

62. The principal observations were taken with Troughton and Simms' 12-inch micrometer theodolite, No. 1. The method of observing was to measure angles on nine zeros, two faces on each zero, and two swings on each face. The mean triangular error, which ranged between 1″·087 and 0″·049, is 0″·40. The computation of the principal triangulation, consisting of three figures (all quadrilaterals), has been completed.

The secondary observations were taken with an 8-inch micrometer theodolite by Troughton and Simms, giving a mean triangular error of 0·85 of a second.

63. The season's out-turn of the Indus delta coast section is as follows:—Thirty beacons have been erected, of which the positions of 17 have been fixed, extending south eastwards 70 miles from Karachi. The positions of the remainder have still to be obtained.

64. The Indus delta observations were taken with a 12-inch vernier theodolite on two zeros, two faces on each zero, and two swings on each face. The mean triangular error is 8 seconds.

An extract from Mr. Prunty's narrative report on the operations of this section will be found in the appendix.

65. Some days were spent at the beginning of the season by Lieutenant Burn in examining the transit instrument in the Rangoon port observatory, set up by Lieutenant Close, of this party, in May 1893. The instrument was found to be in adjustment, and was being worked satisfactorily.

66. Both sections left the field for recess quarters at Mussooree, about the end of April 1894.

67. The health of the party in Upper Burma was not very good, dysentery and pneumonia causing far more distress than fever.

1893-94.

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION OF THE MANDALAY MERIDIONAL AND MÖNGHSAT SECONDARY SERIES, BURMA.

No. 24 PARTY.

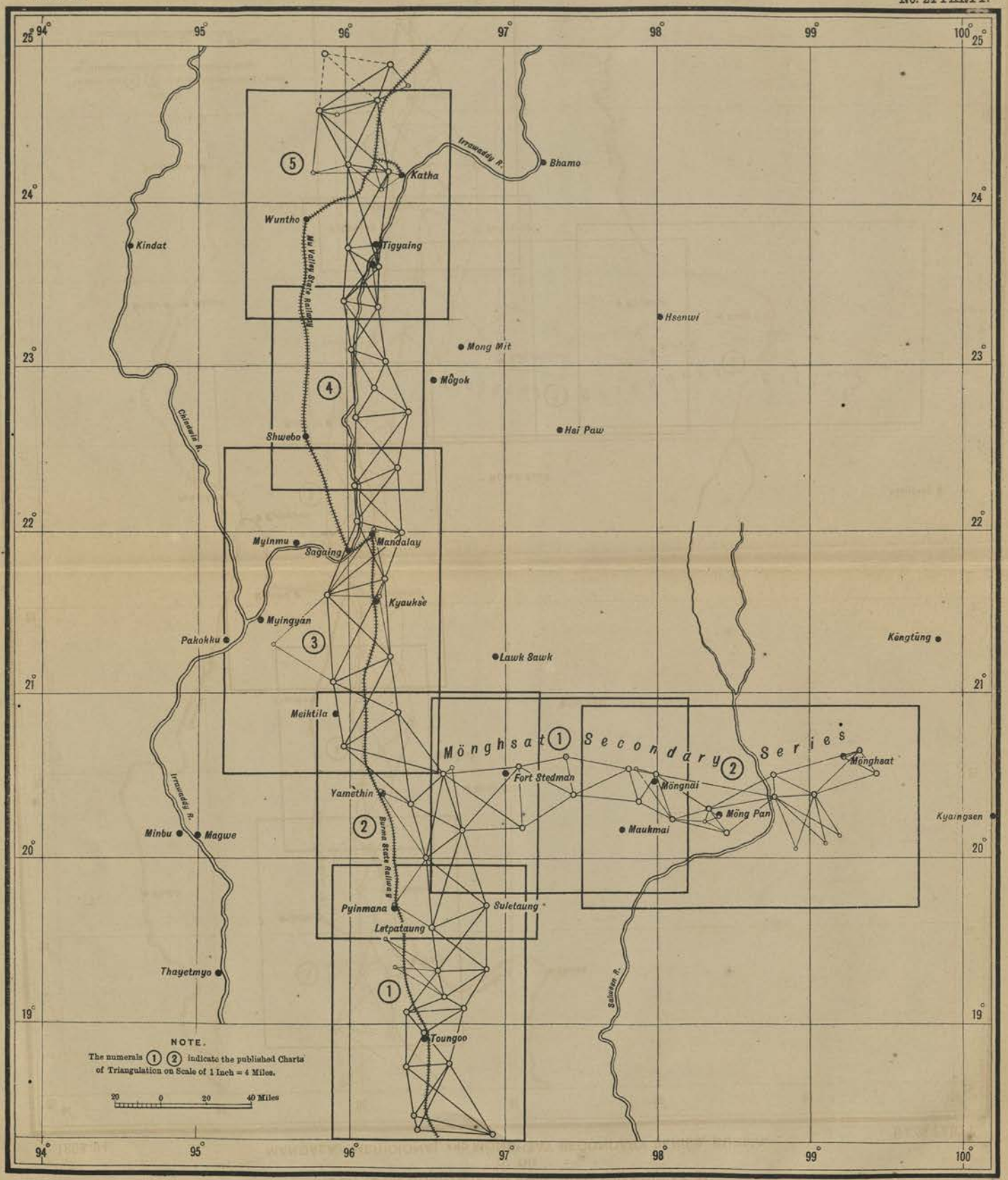


Photo., S. I. O., Calcutta

No. 385-S. 94.

68. Two statements, showing the details, respectively, of the out-turns of the Upper Burma and Indus delta coast sections, will be found at page 1 of the appendix.

69. During the recess, the recess office of the party was inspected by the Superintendent, Trigonometrical Surveys, who reports favourably thereon.*

TOPOGRAPHICAL SURVEYS.

SOUTHERN MARATHA COUNTRY.

No. 10 Party.

70. The work on which this party was engaged during the year was the extension of the topographical survey on the 2-inch scale of the Southern Maratha country and of the Konkan. Major Hobday remained in charge of the party till the 16th May 1894, when he was transferred to No. 17 Party to replace Colonel Hutchinson, who was so unfortunately killed by a tiger. Lieutenant Fraser, R.E., was then placed in charge and held it for the remainder of the year. The party took the field about the middle of November 1893, and returned to recess quarters on the 4th June 1894.

Personnel.

Major J. R. Hobday, S.C., Deputy Superintendent, 1st grade, in charge up to 16th May 1894.
Lieutenant H. A. Denholm Fraser, R.E., officiating Assistant Superintendent, 1st grade, in charge from 16th May 1894.
Mr. W. Todd, Extra Assistant Superintendent, 1st grade, up to 25th November 1893.
„ A. J. Gibson, Extra Assistant Superintendent, 2nd grade.
„ W. Stotesbury, Extra Assistant Superintendent, 4th grade, up to 1st July 1894.
„ C. Tapsell, Extra Assistant Superintendent, 5th grade, up to 13th November 1893.
„ R. R. Dickinson, Extra Assistant Superintendent, 6th grade.
„ G. A. Knight, Extra Assistant Superintendent, 6th grade.
„ J. A. Freeman, Sub-Assistant Superintendent, 3rd grade.
40 surveyors, sub-surveyors, and others.

71. The detail survey of the whole of the Dharwar district, south of lat. 15° 15′ and east of long. 75° was completed, comprising portions of sheets Nos. 308, 309, 310, 311, 334, 335, 336, and 337; also sheets Nos. 176, 208, and 209 and a small portion of sheet No. 210, in the Konkan. In addition to this, the city and cantonment of Belgaum was surveyed on the scale of 8 inches=1 mile. A small amount of traversing for the above survey was necessary, besides which a few traverses were run in portions of the Dharwar district to give supplementary points for the plane-tablers. This year, however, the traversing of village trijunctions in British territory was discontinued for the reasons explained in paragraph 74 of last year's report. Triangulation in advance was effected in sheets Nos. 301, 302, 327, 328, 329, and 349.

72. The total out-turn of the season's work is as follows:—

Triangulation	3,417	square miles.
Traversing	120	linear „
Topography, 2-inch scale	3,768	square „
Ditto 8-inch scale	22	„ „

This is a very satisfactory out-turn, the area surveyed in detail being 1,012 square miles in excess of that of the previous year.

73. The detail survey was tested by 511 miles of chain lines run through it, in addition to *in situ* examinations. A large number of clinometric heights were observed, by means of which considerable uniformity in the representation of the ground by approximate contours has been attained.

74. On the whole, the health of the party was good, but two of the European assistants engaged on triangulation were incapacitated, owing to the extreme heat experienced after the beginning of February in the Bijapur district. During the cold weather months in the Dharwar district the native establishment suffered considerably from fever and ague, brought on by exposure to the cold and treacherous east wind which then prevails.

75. The country surveyed is, in the Dharwar district, open and easy, except along the boundaries of the Kanara district and Mysore State, where there is a

*Lieutenant Burn speaks in high praise of the work done by every member of the party, except one recorder, and specially mentions the excellent work done by Mr. Hickie, and the recorder, Ibrahim Khan.

BOMBAY SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN SOUTHERN MARATHA COUNTRY.

1893-94. No. 10 PARTY.

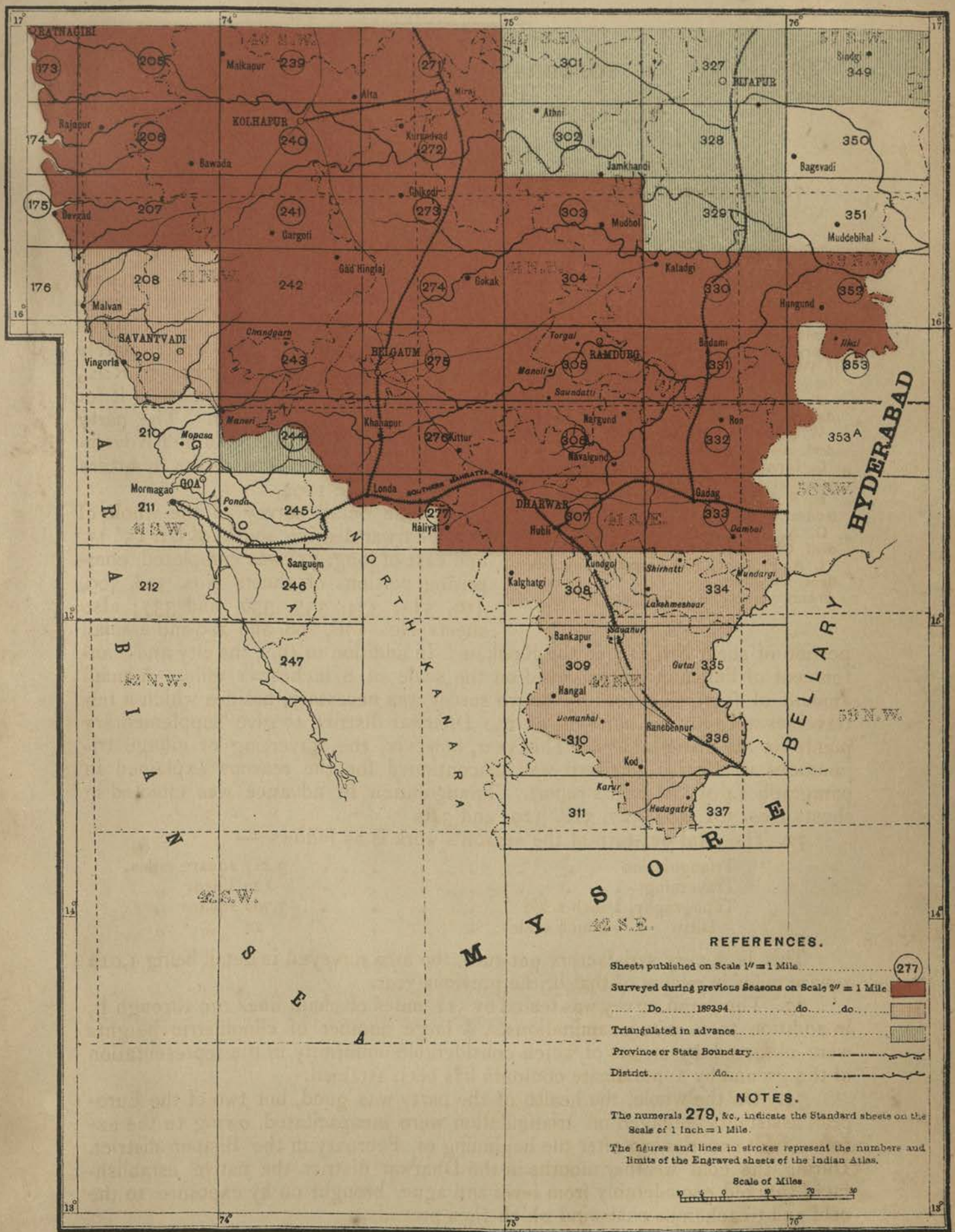


Photo., S. I. O., Calcutta.

Reg. No. 485, S. I. D.—Feb. 96.—650.

No. 335-S. 95.

good deal of dense jungle. In the Konkan, the ground is more difficult being very hilly and in the vicinity of the *ghâts* densely wooded and intricate, whilst nearer the coast the country consists of laterite plateaux, bare and uncultivated and scored with ravines, along the sides of which the cultivation is carried. The villages consist of groups of huts, scattered for miles along the sides of the streams and along the coast line, which is covered with a continuous belt of cocoanut palms.

76. The General Reports of the Gujarat Survey are progressing steadily and will be completed in March 1895. They would have been completed before the end of the current year, but for the fact of both Messrs. Gibson and Dickinson breaking down in health.

77. The Deputy Surveyor-General inspected the party during the field season, visiting some of the sub-surveyors at work. He expresses himself as thoroughly satisfied with all he saw, more especially with the method of running approximate contours as carried out by Major Hobday. The Surveyor-General inspected the recess office at Poona in September 1894. The general progress of the work was found to be satisfactory and the records in good order. Lieutenant Fraser, who has been in charge for the last five months, has completed the season's work very satisfactorily.

78. The programme proposed for next year is as follows:—The detail survey on the 2-inch scale of sheets Nos. 301, 302, 327, and 329, and the triangulation and detail survey of the Portuguese territory of Goa on the one 1-inch scale. Up to date, however, the consent of the Portuguese Government for this latter survey has not been obtained; unless it is received before the 1st December 1894, it will not be possible to complete the whole survey in one year, as was intended. Under these circumstances, therefore, it would be advisable to undertake the triangulation only this year, and to postpone the detail survey until the field season of 1895-96. Advance triangulation will also be taken up in sheets Nos. 350 and 351. The survey of the cantonments of Secunderabad on the 12-inch scale, will also be commenced.*

BALUCHISTAN.

NO. 15 PARTY.

79. This party was divided into four detachments for the work of the field season, exclusive of a small party which was separately organized for the Aden survey under Mr. Tate, and the deputation of two surveyors, Imam Sharif, Khan Bahadur, and Sheik Mohiuddin, on special duty. The four detachments were placed under the supervision of Captain Mackenzie, Mr. Claudius, Mr. Wainwright, and Yusaf Sharif, Khan Bahadur, respectively.

Personnel.

Colonel T. H. Holdich, C.B., C.I.E., R.E., Superintendent, 1st grade, in charge.
Captain R. J. H. L. Mackenzie, R.E., Deputy Superintendent, 2nd grade.
Lieutenant P. J. F. Macaulay, R.E., Assistant Superintendent, 2nd grade, from 17th March 1894.
Lieutenant C. L. Robertson, R.E., Assistant Superintendent, 2nd grade, from 3rd May 1894.
Mr. T. E. M. Claudius, Extra Assistant Superintendent, 4th grade.
„ E. A. Wainwright, Extra Assistant Superintendent, 5th grade.
Yusaf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 2nd grade.
Rai Hira Singh Bahadur, Sub-Assistant Superintendent, 2nd grade.
Imam Sharif, Khan Bahadur, Sub-Assistant Superintendent, 3rd grade.
Mr. P. Williams, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Ahmed Ali, K.B., Abdul Guffar, K.S., Hussain Baksh, Sheik Mohiuddin, Gopal Singh, Jaffer Ali, Mohamed Naki, Nizamuddin, and 16 others.

80. The operations on which the party was engaged were:—

(1) Triangulation for 2-inch, 1-inch and ½-inch scale surveys, and ¼-inch reconnaissance.

* Lieutenant Fraser reports very favourably of all the European assistants. Mr. Stotesbury, who is a most zealous and able officer, both in the field and in recess, supervised the detail survey in the Konkan, and then finished the triangulation left incomplete by the breaking down of Messrs. Dickinson and Gibson successively. Messrs. Knight and Freeman also did good work in triangulation and detail survey respectively. The sub-surveyors, with one exception, worked satisfactorily.

(2) Topography, including—

(*a*) Military surveys round Rawal Pindi on the 2-inch scale including a special survey of the Karur plateau.

(*b*) Surveys in connection with the Afghan Boundary Delimitation in Kurram on the 1-inch scale and in the Zhob Valley on the $\frac{1}{2}$-inch scale.

(*c*) Surveys in Gilgit, Las Bela, and Zhob districts on the $\frac{1}{2}$-inch scale.

(*d*) Reconnaissance surveys in Gilgit, Kurram, Zhob, and Persia, on the $\frac{1}{4}$-inch scale.

(*e*) Reconnaissance surveys in Persia and Arabia on the $\frac{1}{8}$-inch scale.

81. Captain Mackenzie commenced the field season with the extension of triangulation from a base of Mr. McNair's series into the Zhob Valley. He left Loralai about the middle of December 1893, and having reconnoitred 2,500 square miles of country, and partially triangulated it, he was transferred to the Domandi section of the Afghan Boundary Delimitation Commission at the end of February. Two native assistants were with him as topographers, and he specially mentions the work of one of them, Gopal Singh, who continued the topography of the lower Zhob Valley in face of considerable risk after the desertion of his local escort. On transfer to demarcation duty, these surveyors, and Atma Ram from Mr. Claudius' detachment, joined him.

82. Lieutenant Macaulay, R.E., on his appointment to the department, was posted to the Kurram section of the Afghan Boundary Delimitation Commission, which he joined at the end of March and was employed there on survey duty during the remainder of the year under report. Rai Hira Sing Bahadur and Duffadar Lall Sing were also attached to this survey party. The out-turn of work of this section comprised the trigangulation of 1,100 square miles for 1-inch survey, the topography of 600 square miles on the 1-inch scale and of 500 square miles on the $\frac{1}{4}$-inch scale.

83. The detachment under Mr. Claudius (with the head-quarters of the party) took the field in the neighbourhood of Rawal Pindi, and carried on the triangulation and topography of an area of 270 square miles on the 2-inch scale for military purposes. A special survey of the Karur plateau on the 12-inch scale, and a large amount of road revision, was also carried out by this section.

Mr. Claudius' detachment was strengthened by the assistance of Khan Sahib Abdul Guffar and Atma Ram, who had recently returned from special duty in the Gilgit Agency, where they had completed between them 4,574 square miles of survey on the $\frac{1}{2}$ and $\frac{1}{4}$-inch scales, amongst some of the highest mountains of the North-West Himalayas. This out-turn during the two or three summer months when work was possible in such regions is very creditable.

84. The Rawal Pindi detachment was made up of junior native surveyors and soldiers, some of whom turned out excellent work. This survey offered a good opportunity of testing the capabilities of 8 or 10 soldier-surveyors who had not hitherto been employed on regular survey duty, with the result that two or three very competent surveyors have now been added to the list of those whose attainments are known in this department. It is satisfactory to add that the General Officer Commanding Rawal Pindi has expressed his entire approval and appreciation of the work of this detachment. Mr. Claudius returned to head-quarters early in March 1894, leaving Abdul Guffar and two sub-surveyors at Peshawar, for the Khyber section of the Delimitation Commission, and Hira Singh, Rai Bahadur, in the Kurram Valley.

85. Mr. Wainwright, with four of the best of the native assistants, completed 2,508 square miles of $\frac{1}{2}$-inch survey in the difficult districts of Las Bela and Wad, between the beginning of November 1893 and the middle of March 1894. The detachment was much hampered by the hostility of the Brahui tribes among which they were working, and Mr Wainwright deserves credit for having conducted the season's operations without any contretemps. He has added some most valuable notes on the antiquities of these districts to those previously collected on the subject, and these have been incorporated in an

interesting note by Colonel Holdich on the Antiquities, Ethnography and History of Las Bela and Makran, which will be found in the appendix.

86. Yusaf Sharif, Khan Bahadur, completed about 19,000 square miles of triangulation, working from an independent base measured by himself at Jask on the Persian coast. He mapped 10,090 square miles of this country on the $\frac{1}{8}$-inch scale, and his assistant, Jamaluddin, added another 1,700 square miles on the $\frac{1}{4}$-inch scale. This was chiefly in the Bashkurd country, between Bandar Abbas and Jask, and it is most creditable to the Khan Bahadur that he should accomplish so much in the face of determined hostility on the part of the local chiefs, and in spite of serious indisposition which finally led to his being invalided from the field.

87. His brother, Imam Sharif, Khan Bahadur, was attached to an exploring party conducted by Mr. Theodore Bent in Southern Arabia. Mr. Bent has recorded his high appreciation of his services. His out-turn of 12,000 square miles of hitherto unmapped country is very creditable under the difficult and dangerous condition of his service.

88. Sheik Mohiuddin's out-turn of 54,000 square miles of $\frac{1}{8}$-inch reconnaissance is probably a record for this party. He has sent in a special report of this performance which has been separately printed.

89. The total out-turn of the party is as follows :—

	Square miles.
Triangulation for 2-inch survey	260
Ditto 1-inch do.	1,100
Ditto $\frac{1}{2}$-inch do.	2,500
Ditto $\frac{1}{4}$-inch reconnaissance	19,000
TOTAL	22,860
Topographical survey, 1-inch scale	600
Ditto $\frac{1}{2}$-inch do.	226
Ditto $\frac{1}{2}$-inch do.	5,862
Geographical „ $\frac{1}{4}$ and $\frac{1}{8}$-inch scales	84,380
TOTAL	91,068

This out-turn of topography is probably the largest ever recorded by one field party in a single season, and it reflects great credit on all concerned.

90. Colonel Holdich, it is gratifying to record, has received the unusual distinction of appearing in both the London and India Gazettes on the occasion of Her Majesty's last birthday, and in the former was appointed to be a Companion of the Bath for distinguished service in the field, and in the latter a Companion of the Indian Empire for his meritorious services on the frontier.

91. Regarding the programme for the ensuing season, this party has furnished the survey staff for the four different sections of the Afghan Boundary Commission, the work of which (excepting the Kurram section where the demarcation will shortly be completed) will be continued throughout the field season. The small remnant of the party will continue the military surveys on the borders of Baluchistan and also undertake a survey for military purposes of the country within a radius of 6 miles round Mooltan on a scale of 6 inches to a mile, as well as of a certain area along the left bank of the Chenab river on the scale of 2 inches to a mile.*

HIMALAYAS, PUNJAB.

No. 18 Party.

92. The party remained under the charge of Major St. G. C. Gore, R.E., until the 15th April 1894 when he was appointed Superintendent,

* Colonel Holdich reports that Mr. Claudius deserves all credit not only for his management of a large detachment in the field, but of the head-quarter office as well. The services of Mr. Wainwright are also highly spoken of, as well as the work of Yusaf Sharif and Sheik Mohiuddin.
The native assistants generally are said to have given satisfaction in the discharge of their duties.

Trigonometrical Surveys, and his place was taken by Major R. A. Wahab, R.E., who held charge during the recess; about the close of which Major Wahab was nominated as survey officer with the Waziristan Delimitation Commission, and Mr. C. D. Potter was placed in charge of the party as a temporary measure.

Personnel.

Major St. G. C. Gore, R.E., Deputy Superintendent, 1st grade, in charge up to 15th April 1894.
Major R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge from 16th April 1894.
Mr. C. D. Potter, Extra Assistant Superintendent, 5th grade.
„ W. Robert, ditto ditto 5th „
„ W. A. Fielding, ditto ditto 6th „
„ R. Waller-Senior, Sub-Assistant Superintendent, 1st grade.
„ W. M. Gorman, ditto ditto, 3rd „

Surveyors and Sub-Surveyors.

Shah Nasiruddin, Atma Singh, Wahid Ali Khan, Ram Saran, Asmatullah Khan, Dan Singh, Amir Singh, and 21 others.

93. The work, as in the previous season, comprised—

(i) the 4-inch survey of the Kángra district and its sub-division of Kulu, shewing the boundaries of all Government forests, as demarcated by the revenue or forest authorities, in addition to all topographical detail;

(ii) the survey on the 2-inch scale of the Native states of Mandi and Suket;

(iii) the survey on the 4-inch scale of the forests in the Patiála and Sirmúr States with details of growing timber;

(iv) a special survey on the scale of 30 ft.=1 inch of the main streets in the town of Kalka, shewing the ownership and frontage of the houses abutting on the main roads, with a view to prevent encroachments on the road way; also a survey on a scale of 48 inches=1 mile of the whole town.

94. The detachment employed in Kulu, under Mr. Robert, took the field early in September 1893, so as to take full advantage of the few autumn months, in which alone survey work can be satisfactorily carried on in that high and difficult region. This detachment moved down to Mandi in January 1894, and continued the work there during the winter and spring.

The Kángra detachment, under Mr. Fielding, left recess quarters in October 1893, and remained at work in the Kangra district throughout the season.

The third detachment, under Mr. Potter, commenced work in Sirmúr, Umballa and Kalka about the same time, and after completing the programme there, commenced the survey of the small detached forests belonging to Patiála near Chail, some 18 miles east of Simla.

95. The out-turn of triangulation during the year amounts to 568 square miles, which was done by Sub-Surveyor Wahid Ali Khan in the Kangra district for 4-inch detail survey. This completes the triangulation of the portion of that district which lies to the north of the Beas river.

96. The area topographically surveyed during the season amounts to 540 square miles on the 4-inch scale and 304½ square miles on the 2-inch scale, against 475 and 212 square miles respectively of the previous season, which is a satisfactory increase in out-turn.

The areas topographically surveyed in the various localities are as follows:—

Locality.	Scale.	Area in square miles.
Kángra	4 inches=1 mile.	189·0
Hoshiárpur	ditto.	16·0
Kulu	ditto.	205·5
Sirmúr	ditto.	117·0
Patiála	ditto.	12·5
Mandi	2 inches=1 mile.	279·5
Umballa	ditto.	25·0
	TOTAL	844·5

1893-94.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

No. 18 PARTY.

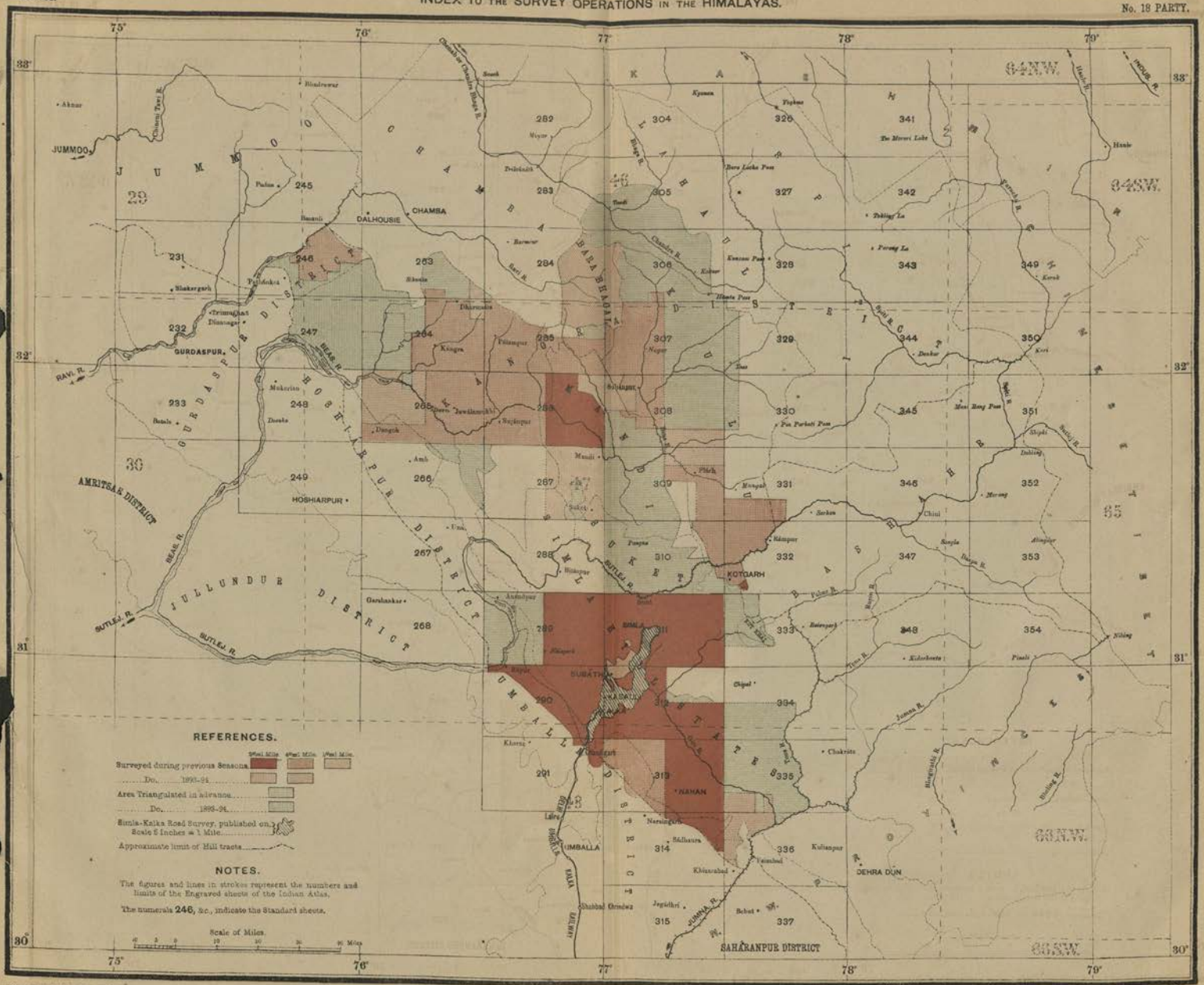


Photo., S. I. O., Calcutta.

No. 333-S. 95.

This out-turn is in excess of that of the previous year by 157 square miles.

97. In the areas surveyed on the 4-inch scale, certain blocks of reserved forests were included, the details of which are shown below:—

Locality.	Number of blocks.	Area in square miles.
Kángra	18	12·4
Kulu	103	68·4
Hoshiárpur	1	3·6
Sirmúr	60	69·9
Patiála	18	6·5
Totals	200	160·8

98. The cost-rates per square mile of the different classes of work are as follows:—Triangulation ₹9·7; detail survey, 2-inch scale, ₹42·9; detail survey, 4-inch scale, ₹82·6. The aggregate cost-rate of the operations for the 4-inch work is thus ₹92·3 per square mile against ₹85·3 in the previous year.

99. The forests in Kángra, Hoshiárpur and the sub-division of Kulu being included in the village demarcation, are surveyed *pari passu* with topographical details and village boundaries; and the cost of these surveys is necessarily reckoned as the average cost of all the 4-inch survey work.

The absence of cleared boundaries and fire lines in the Himalayan forests which increases the cost of traverse work; the high altitude of the forests, mostly in Kulu and partly in Kángra, in which survey work is restricted to the autumn months, and which, on the approach of winter and heavy snowfalls, necessitates change of ground and consequent loss of time and reduced out-turns; the warm clothing and high wages paid to establishments in mountainous tracts, and the high rates of labour and carriage which obtain in the Simla district and in the lower and mid-Himalayas, all influence the cost of Himalayan surveys; yet the cost-rate of ₹92·3 per square mile for the forest surveys of the above districts bears favourable comparison with other surveys governed by similar conditions.

100. Two soldier-surveyors were under instruction during the season, one of whom completed his course during the year, and has rejoined his regiment: both have made excellent progress, and should make valuable military surveyors. One soldier-surveyor joined the party during the recess, and will commence the usual course of training in field duties this season.

101. The recess office of the party at Simla was inspected in July 1894 by the Surveyor-General, who was well satisfied with the progress that had been made in the mapping and with the general arrangements for dealing with the large amount of work that has to be got through in the limited recess season.

102. The programme for the ensuing season comprises the continuation of the operations in Kángra and Kulu, Mandi and Suket, Sirmúr and Patiála, and the special survey of the Kalsia state forests in the Umballa district at the foot of the hills.*

ADEN AND THE YAFI'I COUNTRY.

Detachment.

103. This detachment was organized in October 1893 for the survey of the Aden Peninsula on the scale of 8 inches = 1 mile, and to complete the survey on the ½-inch scale of the portion of the Yafi'i country which was not included in the operations carried out under Major Wahab, R. E., in 1891-92. Subsequently a survey on the scale of 24 inches = 1 mile of Steamer

Personnel.

Mr. G. P. Tate, Sub-Assistant Superintendent, 1st grade, in charge.

Surveyors and Sub-Surveyors.

Asghar Ali Beg, Wahid Buksh, Madat Khan, and Mahomed Ali.

* Majors Gore and Wahab both report most favorably on the work done by Messrs. Potter, Robert, Fielding, and Waller-Senior. Of the Native establishment, Surveyor Shah Nasiruddin and Sub-Surveyors Asmatullah Khan, Ram Saran and the English clerk Amir Singh are commended.

Point, the Aden cantonment with the Isthmus Position, and the Aden troop lines at Khor Maksar was added to the programme.

104. The detachment under the charge of Mr. G. P. Tate left Quetta on the 20th October, and reached Aden on the 6th November 1893.

105. The survey of the Peninsula on the 8-inch scale was completed by the end of February 1894, when the large scale survey of the Aden and Steamer Point cantonments was taken up, and finished early in April.

106. The political arrangements having been duly made for the prosecution of the reconnaissance of the Yafi'i country, Mr. Tate left Aden on the 15th January ,1894 accompanied by the Native Assistant Resident, Khan Bahadur Mahomed Saleh Jaffer, and an escort of the Aden troops to carry out the same. The country operated in was found to be very mountainous and difficult of access, some of the highest points rising over 7,000 feet in height. Moreover, fever of a malarious type was very prevalent, and Mr. Tate and all the party suffered severely. Owing to the friendliness of the Yafi'i Sultan and the excellent arrangements made by the Native Assistant Resident, no opposition whatever was met with, and the work was brought to a satisfactory conclusion. The area triangulated and surveyed in detail on the $\frac{1}{2}$-inch scale, amounted to 1,800 square miles, which forms a most useful addition to Major Wahab's map of 1892. On completion of this reconnaissance the party returned to Aden on the 13th February 1894.

107. The triangulation executed in the Peninsula was based on the work carried out by Major Heaviside, R.E., in 1876-77, while that done in the country of the Lower Yafi'i was based on Major Wahab's extension of that triangulation, and is more or less irregular, as the time available was short and the tribesmen were uneasy, owing to the failure in the rains which had occurred since 1892, which they attributed to the survey operations carried on in that season. Owing to this, no marks could be erected on the hills visited; and as the latter were chiefly composed of short ridges without well-defined peaks, they afforded few facilities for the triangulation. In Aden itself heliotropes were used as signals for the minor secondary stations and cairns and flags for the intersected points.

108. The area triangulated and surveyed on the 8-inch and 24-inch scales amounts to 17 square miles. The work was checked by *in situ* fixings, by plane-table traverses, and, in the cantonment, by traverses run with the theodolite. The dimensions of buildings were checked against the measurements given in the annual return of public military buildings in Aden. The result of the checks applied was satisfactory.

109. The detachment suffered severely from fever throughout the field season. Within a week after landing, the greater part of the menial establishment was prostrated, and Mr. Tate and the native surveyors all suffered from constant recurring attacks of malarial fever. One sub-surveyor was invalided and sent back to India within a month of his arrival in Aden.

110. The detachment left Aden on the 12th April 1894, and reached its recess quarters at Quetta on the 1st May. The maps drawn during the recess include Steamer Point cantonment in two sheets and Aden cantonment with the Isthmus Position and Aden troop lines in four sheets, both on the 24-inch scale, and a general map of Aden in six sheets on the 8-inch scale. Also sheet No. 5 on the $\frac{1}{2}$-inch scale, containing the portion of the Yafi'i country in continuation of the series prepared and published in 1892, and two charts of the Yafi'i and Aden triangulation.

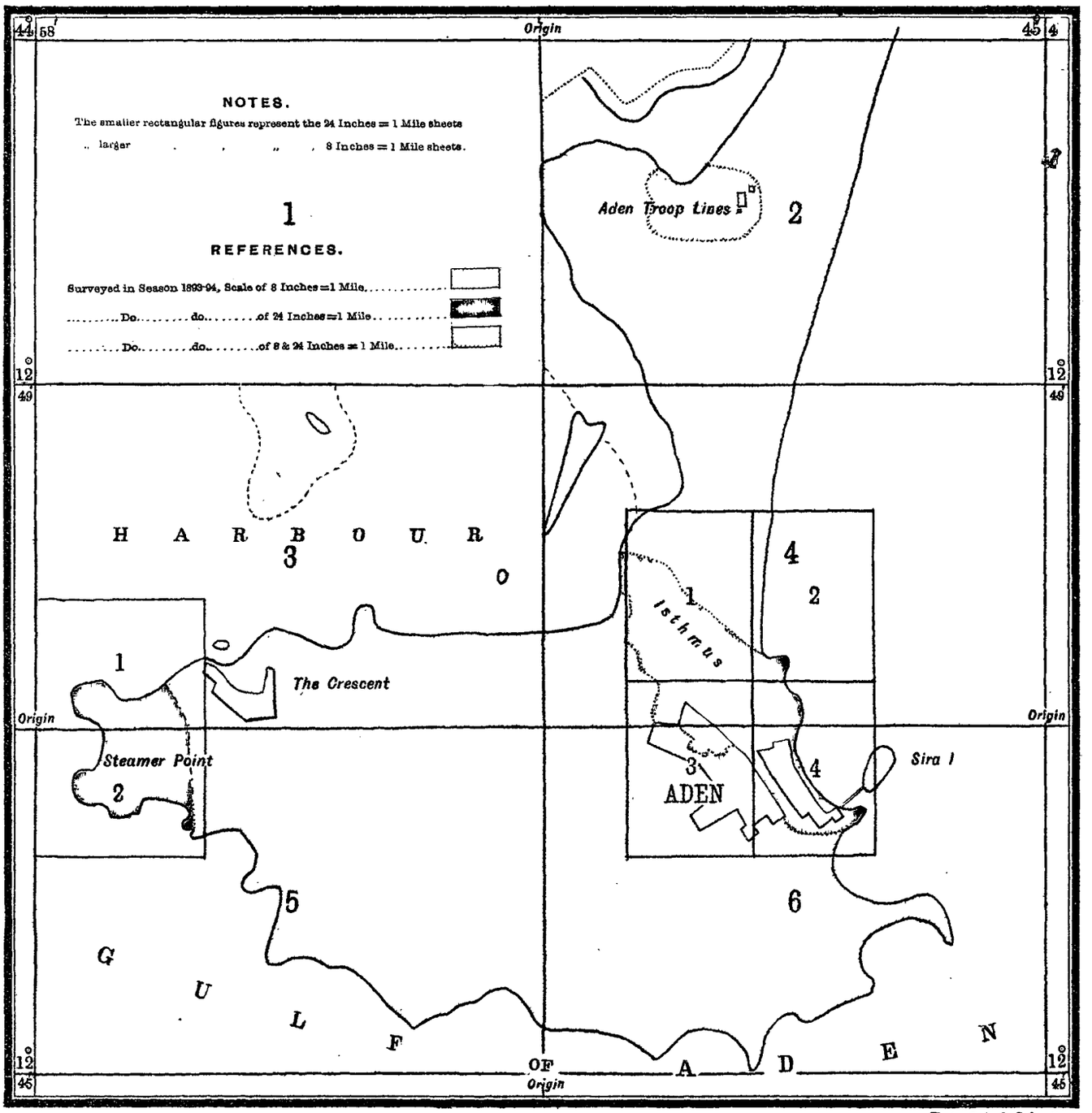
111. Mr. Tate has drawn up an interesting descriptive account of Aden and the country of the Lower Yafi'i, with a brief sketch of the history of Yaman, which has been separately published.

112, The Political Resident at Aden has placed on record his appreciation of the excellent work performed by Mr. Tate and his party while on duty in Aden, and adds that, though continuously suffering from fever, Mr. Tate never flagged in his duty, but carried through the surveys with the greatest credit and energy. The Government of Bombay fully endorsed the favourable notice taken by the Political Resident of Mr. Tate's services, and the Government of India have been pleased to express their concurrence therewith.*

* Mr. Tate reports that all his assistants worked satisfactorily, and makes special mention of the services rendered by Surveyor Asghar Ali Beg.

1893–94.

INDEX TO THE SURVEYS IN PENINSULA OF ADEN.



Reg. No. 607, S. I. D.—Mar. 95.—560.

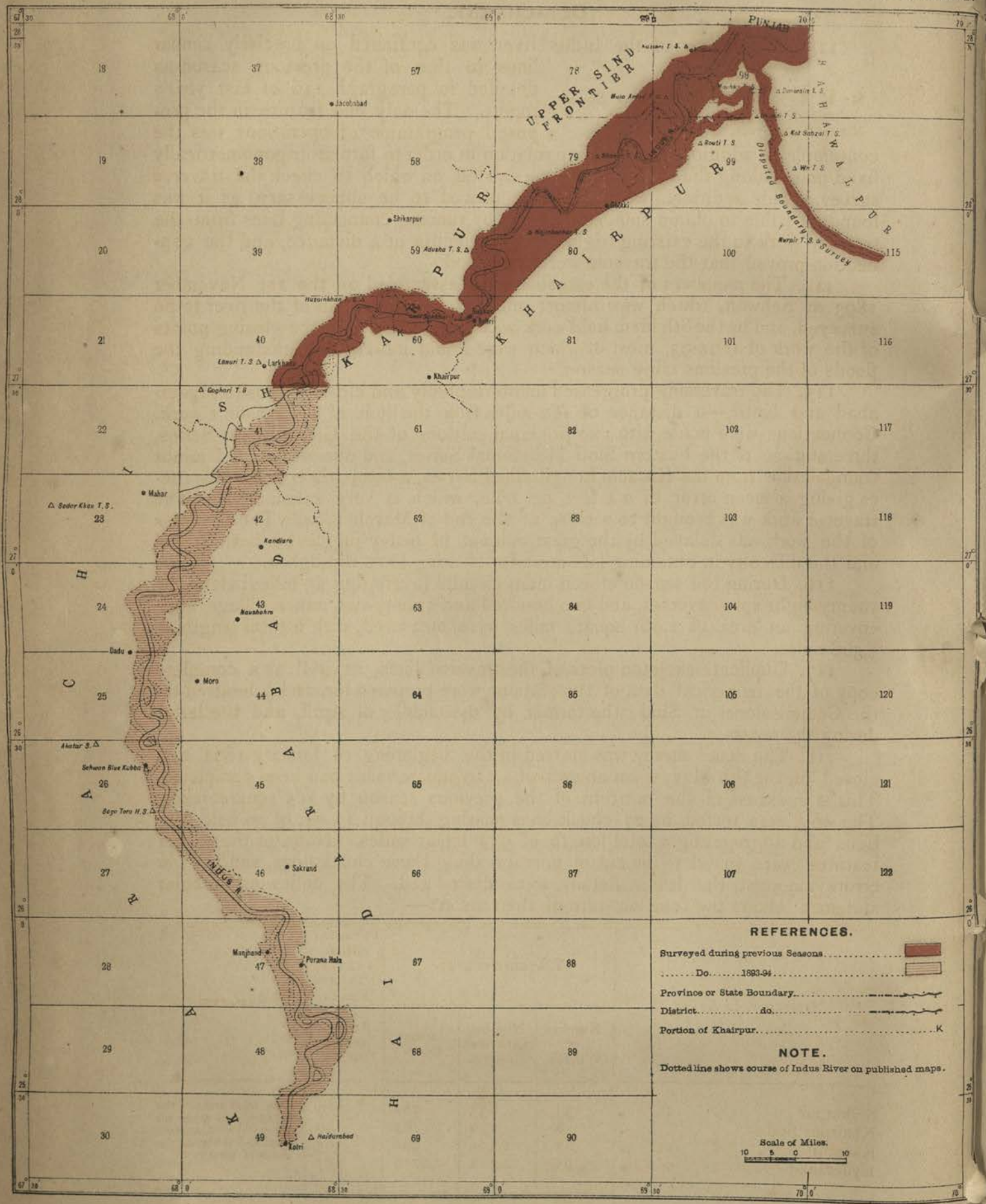
Photo S. I. O. Calcutta.

No. 364-S. 95.

Furlongs 8 7 6 5 4 3 2 1 0 — Scale of Miles 1 3 4 5 Miles

SIND SURVEY.

1893-94. INDEX TO THE INDUS RIVERAIN SURVEY. DETACHMENT.



REFERENCES.

Surveyed during previous Seasons.....

.....Do.....1893-94.....

Province or State Boundary.....

District.....do.....

Portion of Khairpur.....K

NOTE.

Dotted line shows course of Indus River on published maps.

Scale of Miles.

10 5 0 10

Reg No 364. S. I. D.—Mar 96—500.

Photo., S. I. O., Calcutta

No. 360-S. 95.

INDUS RIVER, SIND.

DETACHMENT.

113. The survey of the Indus river was continued on precisely similar lines to that of the previous season as detailed in paragraph 116 of last year's report. The only new feature in the proposed programme of operations was the contemplated addition of some triangulation in order to furnish trigonometrically fixed points along the river where none existed, on which to check the traverse survey. This additional work, however, proved to be unnecessary, as it was found possible to obtain sufficient checks by running connecting lines from the traverse work to the existing trigonometrical points at a distance, and the connection proved that the traverse work was good.

Personnel.

Mr. H. E. Keelan, Extra Assistant Superintendent, 1st grade, in charge.
Nine sub-surveyors.

114. The members of the establishment assembled on the 1st November 1893 at Sehwan, which was almost midway in the portion of the river to be surveyed, and by the 8th idem field work was commenced from the closing points of the work of 1892-93, most of which were found intact, notwithstanding the floods of the previous rainy season.

115. The traversing progressed uninterruptedly and closed opposite Hyderabad and Kotri,—a distance of 160 miles from the limit of last season's work. Connections were made with two principal stations of the Great Indus Series, three stations of the Eastern Sind Meridional Series, and one station of a minor triangulation from the Karachi Longitudinal Series, a comparison of the distances giving a mean error of 2·4 feet per mile, which is very satisfactory. The traverse work was brought to a close at the end of March 1894. The progress of the work was delayed by the great amount of heavy jungle on both banks, and the difficulty in obtaining labourers for clearing lines through it.

116. During the season eleven main circuits (averaging 25 miles in length), twenty-eight sub-traverses, and two hundred and twenty-two minor village lines covering an area of 1,061 square miles were measured, with a total length of 1,568 miles.

117. Duplicate skeleton plots of the traverse lines, as well as a complete copy of the numerical data of the stations were prepared for, and submitted to, the Commissioner in Sind; the former by the middle of April, and the latter during the recess.

118. The detail survey was started in the beginning of January 1894 and closed on the 8th May, when an area of 1,219 square miles had been completed. This is in excess of the out-turn of the previous season by 105 square miles. The work was tested by 27 check lines passing through 17 out of 20 field sections and aggregating a total length of 95½ linear miles. None of the larger features were found to be out of position along those check lines, and but few errors amongst the lesser details were discovered. The following tabular statement shows the total out-turn of the season:—

District or State.	Traverse survey.			Topographical survey, 1 inch = 1 mile.	Remarks.
	Number of villages.	Number of traverse stations.	Linear miles.	Area in square miles.	
Shikarpur	33	833	282	219	* The total areas of the villages were not in all cases surveyed, as some portions fell beyond the limits of survey.
Khairpur State	8	190	64	50	
Karachi	63	1,495	506	393	
Hyderabad	95	2,118	716	557	
Totals	199*	4,636	1,568	1,219	

119. The detachment returned to recess quarters at Karachi on the 10th May 1894 and the duties of the recess commenced shortly afterwards. The fair

mapping of 14 sheets of the Indus riverain survey were completed. Tracings of seven plane-table sections of the season's work were also prepared for the Engineer-in-Chief, North-Western Railway, in order to aid him in the work of protecting the railway lines affected by floods on the river.

120. The total expenditure on the work of the season amounted to ₹25,067, the cost-rate per square mile being ₹22-6-5.

121. The ensuing season's operations will consist of the survey of the Indus river from Hyderabad to the mouths of its two main arms, the Ochto and the Hydari, including the country between them; the area of topographical survey will therefore be larger than the out-turn of either of the last two seasons.

As the country is of a marshy nature and intersected by tidal creeks, it will be necessary to provide a steam launch for the officer in charge and country boats for the sub-surveyors, or they will not be able to complete the whole programme.*

FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 Party.

122. The charge of this party remained in the hands of Colonel J. R. Wilmer, S. C., up to the 2nd of April 1894, when he proceeded on furlough, and it then temporarily devolved on Mr. N. C. Gwynne, who retained it till the party returned to recess quarters. Captain W. J. Bythell, R.E., was then posted to the party, and retained charge till the end of the survey year.

Personnel.

Colonel J. R. Wilmer, S.C., Superintendent, 2nd grade, in charge up to 2nd April 1894.
Captain W. J. Bythell, R.E., Deputy Superintendent, 2nd grade, in charge from 14th May 1894.
Mr. N. C. Gwynne, Extra Assistant Superintendent, 3rd grade, in charge from 3rd April to 13th May 1894.
„ J. Keating, Extra Assistant Superintendent, 6th grade,
„ D. Campbell, Sub-Assistant Superintendent, 1st grade.
„ B. R. Hughes, ditto ditto 1st grade.
Munshi Rahmatullah ditto ditto 3rd grade.
Mr. J. O. Greiff ditto ditto 3rd grade.

Surveyors and Sub-Surveyors.

Muhammad Zakaria, Hydar Ali, Gurdat Singh, Kadir Sharif, Karemdad Khan, Ram Singh and 48 others.

123. In continuation of previous year's work, this party was employed in surveying the 1st or "A" class forest reserves of district Nimar, on the 4-inch scale. It also commenced operations in the forests remaining to be surveyed in district Betul.

124. The party assembled at Burhánpur on 1st December 1893, and field operations were commenced in the third week of December and continued until the end of April 1894. The field office was closed at Khandwa on 2nd May 1894, but one triangulator and eight traverse surveyors were left in the field to complete the triangulation and traverse work remaining to be done in Nimar district: this they finished by the 12th of June 1894.

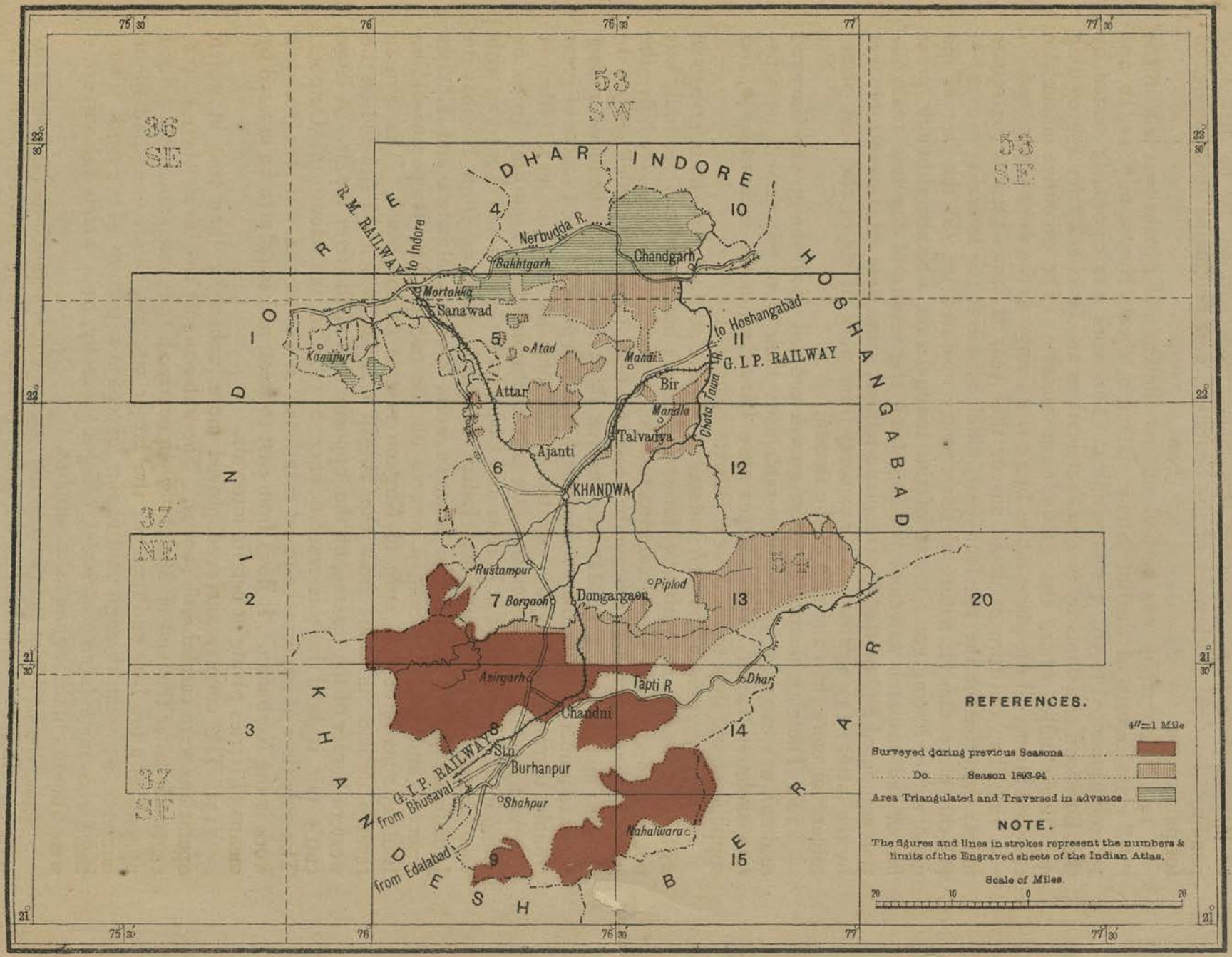
125. Triangulation was done in advance of topography in sheets Nos. 1, 5, 10, and 11 in district Nimar, and in sheets Nos. 20, 21, 27, 28, 38, and 39 in district Betul. In Nimar district, the country in portions of Punása and Chándgarh reserves is almost flat and covered with very dense forest, but cut up with numerous ravines. It was found impossible to carry out any satisfactory triangulation there. Additional traversing was, therefore, resorted to over that ground for the purpose of affording sufficient fixed points for the detail survey. All roads and streams of importance were taken up, and the traverses connected to triangulated points where possible.

The total area of triangulation done during the season was 430 square miles in Nimar district, and 434 square miles in Betul district, embracing 315 and 286 square miles, respectively, of area for actual topography. Out of the triangulated area, 103 square miles in Nimar district was surveyed in detail during the season, so that an area of 761 square miles is in advance for the detail survey of next season.

* Mr. Keelan reports that the sub-surveyors and computers as usual worked throughout the field season and during the recess with unfailing energy and accuracy, and have given complete satisfaction.

CENTRAL PROVINCES SURVEY.

1893-94. **INDEX TO THE FOREST SURVEY IN DIST. NIMAR.** No. 14 PARTY.



Reg. No. 810, S. I. D.—Feb. 95.—550.

Photo., S. I. O., Calcutta.

No. 340-S. 95.

126. Traversing of the forest boundaries and fire lines was done as usual, and additional traverses run, where needed, for the purpose of supplying the detail surveyors with more fixed points. The out-turn of traversing was 562 linear miles in district Nimar, and 305 linear miles in district Betul. The boundary between Nimar and Holkar's territory, referred to in paragraph 130 of last year's report, was re-traversed during this season. In the previous year this boundary was not traversed direct from one masonry pillar to another, on account of the thickness of the intervening jungle, and from the fact that the line had not been cut and cleared by the Forest Department. This year the boundary line was properly demarcated and then traversed with the theodolite. Four fair maps of last year's survey containing this boundary, which had to be held back pending the final settlement of the boundary, were completed and despatched for publication.

127. Topography was carried out on the scale of 4 inches=1 mile in the "A" class forests of district Nimar, falling in sheets Nos. 5, 6, 7, 11, 12, and 13, and amounted to 565·3 square miles. The work was rigorously tested by the European assistants by *in situ* examinations and by check lines aggregating 311 linear miles where the ground was suitable. The executive officer also checked almost all the plane tables by *in situ* fixings as the work progressed.

128. The out-turn of detail survey this year is somewhat less (63 square miles) than that of the previous year, which is due to the following causes:—(1) the more difficult nature of the country operated in; (2) the fact of the detail survey having got abreast of the triangulation, whereby although great labour and despatch was employed in getting the results of the new triangulation computed and plotted for the plane-tablers, some time was unavoidably lost by the latter; (3) sickness and incapacity from work of six of the best plane-tablers for more than a month of the season.

129. The classification of forest growth and soil of all the ground surveyed in detail was executed by the plane-tablers as their work progressed, on separate skeleton traces. These traces were fair-drawn in the recess season, and supplied, in original, to the Forest Officers concerned.

130. The country surveyed in detail is, in some portions, flat and interspersed with low hills covered with *salai* forest and grass; but the ground generally was not easy to survey. The Gondwána reserve, in sheet No. 13, is very hilly, the ground being covered with heavy bamboo and teak jungle with thick grass. In Bhainsa and a portion of Mándwa reserve thick rank grass abounded, giving cover to numerous small thorny *khair* bushes, which proved to be a source of great trouble, tearing the surveyors' clothes and cutting the *khalásis* legs. Bhainsa reserve takes its name from the fact that the wild buffalo (*bhainsa*) is to be found in it. The ground in Punása and Chándgarh reserves was overgrown with very dense forest. The Great Indian Peninsula Railway from Bombay to Jubbulpore passes through the season's work, crossing Mándwa and Kharda reserves and touching Singáji reserve on the north. The Rajputana-Malwa Railway runs through a strip of Kirgaon reserve to the south. The Singàji reserve derives its name from the Singáji temples, which are situated on the western border of the reserve, on the opposite side of the river Piprár. A large cattle fair is held in this reserve once a year in the month of October. The only river of importance to be mentioned in connection with the season's work is the Nerbudda. It flows from east to west, and is only to be crossed by means of ferries plying at certain intervals.

131. The country surveyed proved more unhealthy than that in which operations were carried on last year. The water-supply was everywhere scarce, especially after the end of March, when nearly all the tanks, pools, etc., dried up, except a few here and there in the larger streams. Provisions had to be imported, as usual, through paid *banias*, except in a portion of the work where there were some large *malguzári* villages close by, from which the surveyors were able to obtain the requisite supplies.

132. The health of the party in the season under report was far from satisfactory. In the early portion of the season the establishment suffered from fever and dysentery, and there were a few cases of pneumonia—almost all of which proved fatal. During March and April 1894, however, the establishment fared better; but towards the end of the season sun fever and dysentery were again prevalent. The squads working in the Betul district suffered greatly from fever

and catarrh throughout the field season. There would appear to have been an epidemic in Betul this year which swept over the whole district, as the villagers also suffered from the same maladies to an unusual extent. The number of deaths in the party during the season amounted to 13.

133. The fair mapping pertaining to the season's topography, comprising 37 standard sized sections of sheets Nos. 5, 6, 7, 11, 12, and 13, will be completed during the recess, as well as all the computations of triangulation and traversing done during the season; and there will be no arrears of work by the time the party proceeds to the field.

In addition to the above, the revised map of the Mussooree cemetery has been drawn in the office of the party for reproduction, and an index map of the forest surveys of district Damoh has also been prepared.

The General Report of Hoshangabad and Betul forest surveys is in course of preparation.

134. At the special request of the Conservator of Forests, Northern Circle, the traverse data of forest boundaries surveyed by this party are being prepared for the use of the Forest Department. These data consist of a record of rectangular co-ordinates of all the forest boundary pillars, and index maps on the scale of 1 inch=2 miles showing the position of every tenth traverse station. The above data for Hoshangabad district are almost finished, and will be supplied to the Conservator of Forests on completion. According to the wishes of the Forest Department, this party is to continue preparing these data as the survey work progresses in the Central Provinces.

135. Although the out-turn of final survey is somewhat less than last year, it is satisfactory to note that the cost rate thereof has been further reduced by over 10 per cent., which is due to a smaller expenditure having been incurred, owing principally to the circumstances that compensation for the dearness of provisions had not to be granted to the menial establishment this year. The main cause that affects the cost-rate of work in this party is the short season during which field operations can be carried on owing to the tracts operated being extremely unhealthy. The field work has consequently to be restricted to a period of a little over four months instead of six months as is usual in other parties, and the out-turn is thus unavoidably smaller. There has, however, been a steady decrease in the cost-rates of this party for the past four years, as the following statement of the rates per square mile for each class of work will show:—

	Triangulation.	Traversing.	Topography.
	₹	₹	₹
1890-91	28·7	15·4	125·5
1891-92	21·1	22·5	118·8
1892-93	19·0	21·5	99·5
1893-94	17·7	17·8	89·0

It is hardly to be expected that the cost-rate can be reduced much during the coming year, on account of the more difficult nature of the country in which operations are to be carried on, notably the Punása and Chándgarh reserves in district Nimar.

136. Three native military students joined the party for survey training in December 1893. They were sent out with the old surveyors of the party to be taught the principles and the method of detail survey, and were under instruction throughout the field season. A fourth military student was attached to the party on 25th July 1894; and he, with the other three, was employed in practising drawing and printing during the recess season. These men will be given some more lessons in plane-tabling before the party goes to the field, to fit them for employment on independent survey work in the coming field season.

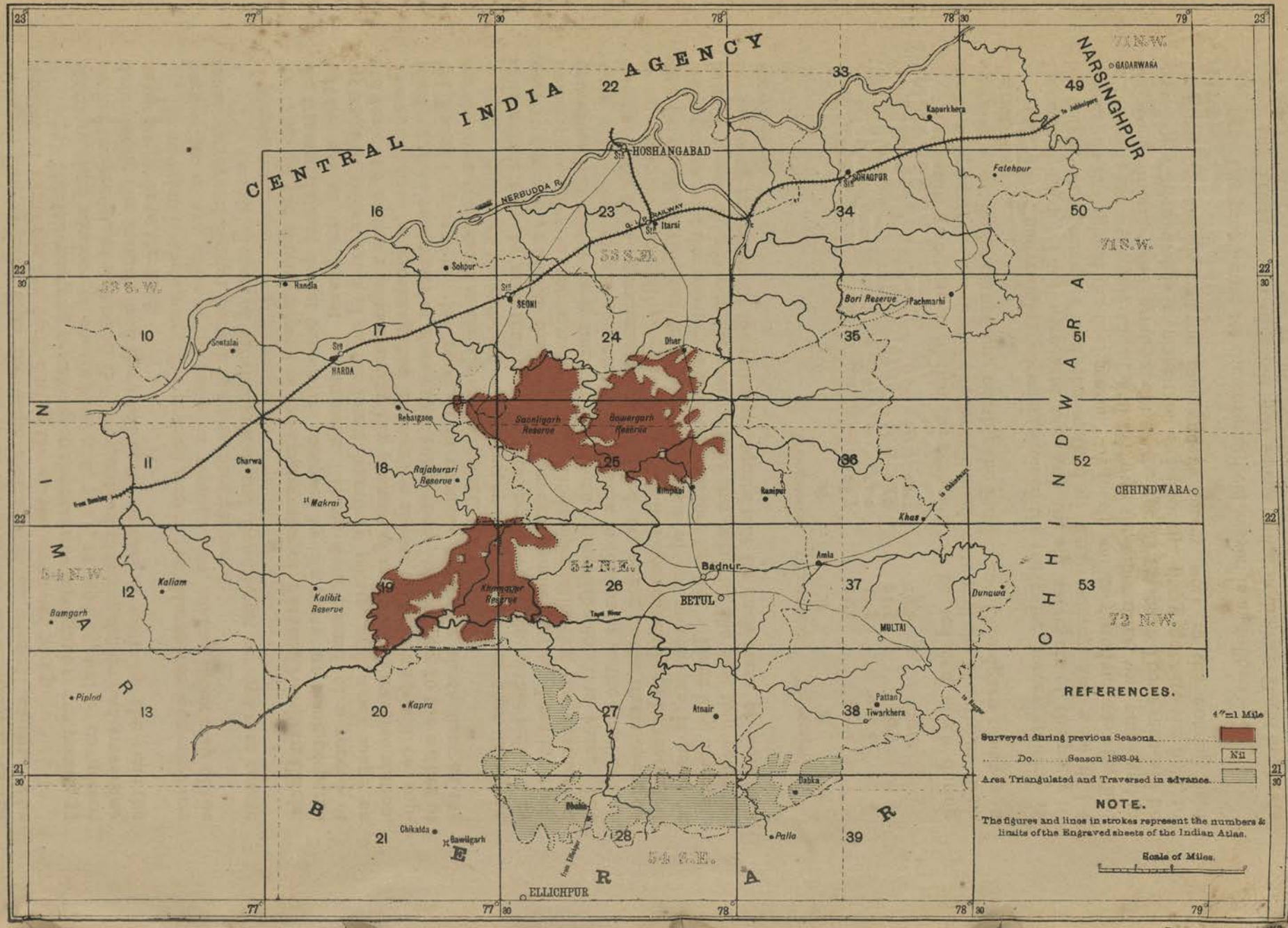
137. The programme for the ensuing field season is as follows:—

(*a*) Triangulation of about 450 square miles in district Betul in sheets Nos. 19, 25, 26, 35, 36, 37; also of about 500 square miles in district Damoh, which has now been allotted for survey.

(*b*) Detail survey of about 212 square miles in district Nimar in sheets Nos. 1, 4, 5, and 10; and of about 310 square miles in district Betul in sheets Nos. 19, 20, 26, 27, 28, 37, 38, and 39;

CENTRAL PROVINCES SURVEY.

1893-94. **INDEX TO THE FOREST SURVEY IN DIST. BETUL.** No. 14 PARTY.



No. 304, S. I. D.—Feb. 95.—600.

Photo., S. I. O., Ca...

No. 339-S. 95.

(*c*) Theodolite traversing of all the forest boundaries, external and internal, and of principal roads and fire lines in the ground to be triangulated;
(*d*) Classification of forest growth and soil of the area to be surveyed in detail.

138. The office of the party was inspected by the Superintendent, Trigonometrical Surveys, at Mussooree, on the 20th of June, who expressed his satisfaction at the orderly and methodical manner in which the work of the office is conducted.*

BOMBAY PRESIDENCY.

NO. 17 PARTY.

139. This party remained in the charge of Colonel H. S. Hutchinson until the 27th April 1894, on which date that officer most unfortunately met his death from a wounded tiger which he was following up in the Kanara forests. The charge then devolved temporarily upon Mr. C. E. Tapsell, Extra Assistant Superintendent, until the 11th May, when Major Hobday assumed charge. Mr. Tapsell again held temporary charge for three months from the 27th July, during the absence of Major Hobday on privilege leave.

Personnel.

Colonel H. S. Hutchinson, S. C., Superintendent, 2nd grade, in charge up to 27th April 1894.
Major J. R. Hobday, S. C., Deputy Superintendent, 1st grade, in charge from 11th May to 26th July 1894.
Mr. A. M. Lawson, Extra Assistant Superintendent, 1st grade, up to 17th December 1893, retired.
„ C. E. Tapsell, Extra Assistant Superintendent, 5th grade, from 13th November 1893, and in charge from 28th April to 10th May, and again from 27th July 1894.
„ S. F. Norman, Sub-Assistant Superintendent, 1st grade.
„ C. A. Norman, Sub-Assistant Superintendent, 1st grade.

Surveyors and Sub-Surveyors.

Gopal Vishnu, G. R. Bhopatkar, Govind Gopal, R. V. Joshi, N. V. Bhopatkar, V. G. Bhat, and 30 others.

Mr. A. M. Lawson, Extra Assistant Superintendent, retired on superannuation pension on the 18th December 1893, after 31 years' meritorious service in the department.

140. The party was engaged, as in previous years, on the survey of forest tracts in the Bombay Presidency. Tho season's work comprised:—

(1) Triangulation in the North Kanara and Poona districts.
(2) Surveys on the 16-inch scale of *babul* reserves in the Poona, Ahmednagar, and Sholapur districts.
(3) Surveys on the 8-inch scale of teak reserves in the Poona, Ahmednagar, Thana, and Kolaba districts.
(4) Surveys on the 4-inch scale of ordinary forest reserves in the North Kanara and Poona districts.

141. The party took the field in the beginning of November 1893, and returned to recess quarters about the end of May 1894.

142. The advance triangulation in North Kanara was undertaken by Mr. Tapsell early in the season and continued till the middle of January. The area triangulated was 265 square miles, besides which supplementary points were fixed in 100 square miles of the previous season's work where they were needed. The operations were carried over the densely clad forest plateau lying between the Kalinadi and Gangavalli rivers in sheets Nos. 247 and 279, which is a very difficult country to triangulate owing to the thick expanse of evergreen forests and to the want of prominent natural features in it. In addition to the area triangulated by Mr. Tapsell, a further area of 200 square miles was effected in the Poona district by Surveyor Gopal Vishnu.

A small out-turn of 215 linear miles of traversing in advance of the plane-tabling in the Kanara district was completed by Sub-Surveyor Ram Chunder Joshi.

143. Colonel Hutchinson personally superintended the 16-inch surveys of *babul* reserves in the Ahmednagar district, and Mr. Lawson took charge of similar work in the Sholapur district. These surveys were carried out in the

* Captain Bythell reports well of all his Assistants. The following members of the Native establishment are specially mentioned:—

Hydar Ali, Gurdat Singh, Kadir Sharif, Karimdad Khan, Ram Singh, Mahadeo Daji, Sutto Charan Ghosal, Surjan Singh, Abdul Haq (1), Dharmu, Muhammad Zakaria, and Syed Zille Hasnain.

early part of the field season, and the total area mapped on the 16-inch scale amounted to 65 square miles.

144. Messrs. S. and C. Norman supervised the two sections engaged on 8-inch surveys in the Northern and Central Forest Circles. These sections first completed the area remaining to be surveyed on this scale in the Junnar *taluka*, Poona district, and also carried out the survey of *babul* reserves on the 16-inch scale in the vicinity. The work in the Poona district was completed on 10th February, when the section under Mr. S. Norman proceeded *viâ* the Malsej Ghât to the Thana district to take up the survey on the 8-inch scale of reserves in the Salsette and Vada *talukas*; and the section under Mr. C. Norman went to the Pen *taluka* of the Kolaba district for similar work. The operations in these localities were continued until the end of the field season. The total out-turn of topography on the 8-inch scale amounts to 222 square miles.

145. The survey on the 4-inch scale was almost entirely confined to the Southern Circle, in the Supa *taluka* of the Kanara district. This section was supervised by Mr. Tapsell on completion of his traingulation, and an area of 193 square miles in sheet No. 246 was effected. A small area of 9 square miles was also surveyed by this section on the 4-inch scale in the Haveli *taluka*, Poona district, making the aggregate out-turn of topography on this scale to be 202 square miles.

146. Colonel Hutchinson visited the different camps in Junnar, Kolaba and Kanara in succession and inspected the work in each. The whole of the detail survey was checked by European agency, by rigorous chain measurements where the nature of the ground permitted and elsewhere by *in situ* examinations, and it is reported to be very accurate, considering the very difficult nature of the country operated in. The aggregate length of the check traverses amounted to 270 linear miles.

147. The aggregate out-turn and average cost-rates of the different classes of work done during the field season are as follows:—

Description.	Areas.	Cost-rates.
	Square miles.	₹
Triangulation	465	10·8
Traversing	250	12·6
Topography, 4-inch scale	202	84·8
Ditto 8-inch „	222	156·4
Ditto 16-inch „	65	179·5

The out-turn of topography is 63 square miles in excess of that of the previous year.

148. The cost-rates of the forest surveys on the different scales, done by this party during the past three seasons are given in the following statement, and show a steady annual diminution in the total rates:—

Description.	1891-92.		1892-93.		1893-94.		Remarks.
	Areas.	Cost-rates.	Areas.	Cost-rates.	Areas.	Cost-rates.	
	Sq. miles.	₹	Sq. miles.	₹	Sq. miles.	₹	
4-inch Surveys.							
Triangulation	150	22·1	750	13·0	465	10·8	
Traversing	...	18·7	...	21·7	250	12·6	
Detail survey	195	85·4	220	80·6	202	84·8	
Total rates	...	126·2	...	115·3	...	108·2	
8-inch Surveys.							
Triangulation	458	5·8	245	10·5	...	...	
Traversing	...	26·5	...	15·5	...	...	
Detail survey	202	162·0	185	150·8	222	156·4	
Total rates	...	194·3	...	176·8	...	156·4	
16-inch Surveys.							
Detail survey	40	187·4	22	189·7	65	179·5	No triangulation or traversing required.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTHERN CIRCLE (N. KANARA).

1893-94. No. 17 PARTY.

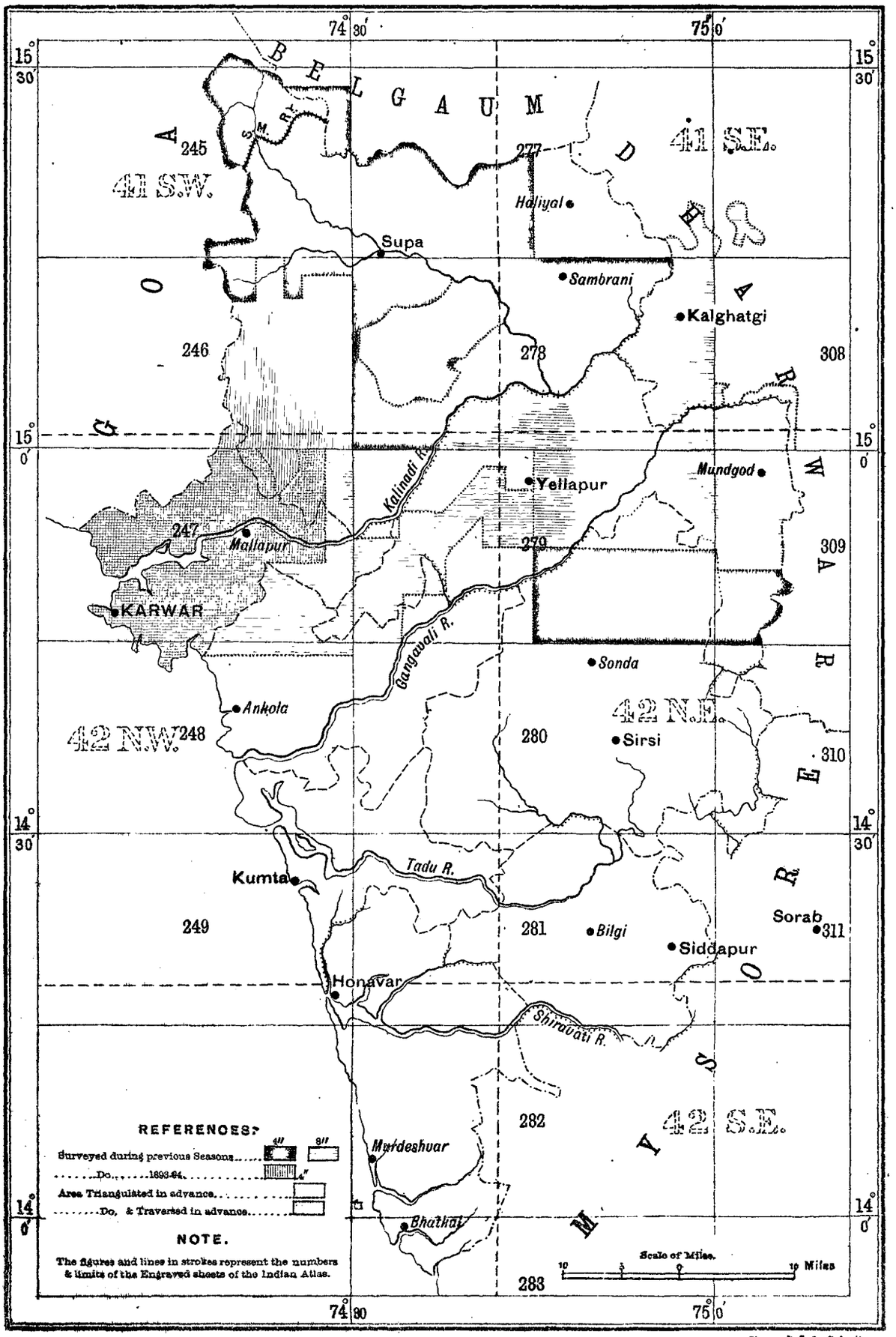


Photo., S. I. O., Calcutta.

Reg. No. 697, S. I. D.—Jan. 95.—550.

No. 326-S 95.

149. The rates are still high, and this is principally due to the work being so widely scattered. The cost-rates of survey will, generally speaking, vary inversely as the areas completed, and it is hoped to obtain larger areas in future and thus diminish cost-rates by—

(1) concentrating the work of the party, whereby loss of time in making any great moves during the field season will be avoided;
(2) increasing the staff of sub-surveyors;
(3) introducing a better class of sub-surveyors.

150. Colonel Hutchinson, who had been in charge of this party for three years, was killed as previously stated by a wounded tiger towards the close of the field season in the Western Ghâts near Castle Rock. He was an able officer of ripe experience, having served in the department for 27 years in the Revenue and Topographical branches, in which he had done much useful work. His sudden and untimely death is deeply regretted.

151. During the recess a very large out-turn of mapping has been executed, which exceeds anything that has been done by the party since its formation. It includes two standard-sized sheets, on the 2-inch scale, reduced by pentagraph for reproduction; 8 standard-sized sections drawn on the 4-inch scale; 67 sections drawn on the 8-inch scale, and 84 sections drawn on the 16-inch scale. The 2-inch and 4-inch maps were drawn *de novo*, but of the 8-inch and 16-inch maps, many of the field sections being suitable for photographic reproduction, were utilised to make up the fair maps, and the labour of re-drawing them was thus saved. A triangulation chart in duplicate and a traverse chart of sheet No. 247, Kanara district, were prepared on the 1-inch scale.

The computations of the season's triangulation and traversing have been brought up to date.

152. The programme for the ensuing field season is as follows:—

Northern Circle.—In the North and South Thana districts, continuation of 8-inch detail survey in the Vada *taluka* and triangulation and traversing in advance in the Mahim, Dabanu, and Shahapur *talukas*.

Central Circle.—In the Ahmednagar and Poona districts, continuation of 16-inch and 8-inch surveys, and advance triangulation and traversing, in the Akola, Sangamner, Haveli, and Purandhar *talukas*.

Southern Circle.—In Kolaba district, continuation of 8-inch surveys in the Pen and Alibag *talukas*, and advance triangulation and traversing for 4-inch surveys in North Kanara district.

It is proposed to relinquish all detail surveys in Kanara district every third year, commencing next season, and to obtain in lieu a sufficient area of triangulation and traverse in advance for the two following seasons. It is hoped that by the adoption of this scheme a larger staff of surveyors can be employed on the detail survey hereafter, and thus increase the out-turn and diminish cost-rates.

153. The recess office of the party at Poona was inspected by the Surveyor-General during September 1894, and he was well satisfied with the results of the year's operations and with the general efficiency of the establishment. The field sections showed that the survey had been executed with care and the maps give an excellent representation of the hill features, drawn in a manner well suited for reproduction by photography. The professional records were found to be systematically arranged and well kept.*

* Major Hobday reports that Messrs. Tapsell, S. F. Norman, and C. A. Norman have given entire satisfaction in the discharge of their duties. These assistants worked steadily in the field and have given valuable aid in carrying to a successful completion the large amount of mapping that had to be done in the recess office.

The surveyors and sub-surveyors, with a few exceptions, are said to have afforded the usual amount of satisfaction.

MADRAS PRESIDENCY.

No. 19 Party.

154. This party was employed during the season on the survey of forest reserves in Madura, Salem, and North Arcot districts in continuation of the work of previous seasons.

Personnel.

Major R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge up to 1st April 1894.
Captain H. M. Jackson, R.E., Deputy Superintendent, 1st grade, in charge from 2nd April, 1894.
Mr. C. F. Hamer, Extra Assistant Superintendent, 4th grade.
„ H. Todd, ditto 4th grade.
„ R. Todd, ditto 6th grade.
„ J. H. S. Wilson, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Raghavayangar, Tiruvenkatasamy, Balaji Dhondiba, Govindaraju, Ramaswamy Naidu, Anantarao Dhondiba, and 24 others.

155. On the 1st October 1893, Major R. A. Wahab, R.E., took over charge from Lieutenant-Colonel J. R. McCullagh, R.E., proceeding on furlough, and on the 2nd April 1894, Captain H. M. Jackson, R.E., relieved Major Wahab on that officer's transfer to No. 18 Party. The party, as in previous years, was divided into three sections, No. 1 section under Mr. R. Todd for triangulation, and Nos. 2 and 3 sections under Messrs. Hamer and H. Todd respectively for detail survey.

156. The recess office was closed on 31st August 1893 and survey operations were commenced early in September and continued until the first week in March 1894. During the season, No. 1 section extended the triangulation in Salem and North Arcot; No. 2 section continued detail survey in Salem district, and completed the survey of some reserves in the Palni hills in the Madura district, which remained over from the previous season; No. 3 section carried on the work in North Arcot.

157. The area triangulated amounts altogether to 2,000 square miles. Traverse operations amounting to 620 linear miles were carried out, and an area of 881 square miles was topographically surveyed on the 4-inch scale. This again shows a considerable advance (nearly 100 square miles) on the out-turn of the previous year; and it is hoped that as the party, which, owing to its rapid enlargement, still contains a considerable proportion of young surveyors, gains experience, a steadily increasing out-turn will be obtained.

158. The usual monsoon rain in November somewhat retarded progress during that month, but the health of the party was not affected, and with the exception of a few cases of cholera, which is always more or less prevalent in Salem and Arcot, there was no sickness throughout the season.

159. The country surveyed is everywhere mountainous and in many parts covered with dense jungle. The average elevation of the hill tops exceeds 3,000 feet, and in the Chitteri and Kalrayan hills some peaks rise above 4,000 feet. Both on these hills and in the Palmaner *taluk* of North Arcot there are numerous hill villages with a considerable, though scattered area of cultivation. As the demarcation of these villages has not yet been carried out, the whole area, as in the case of the Shevaroy hills last season, has been surveyed; and the limits of cultivation as existing at the time of survey have been shown. This procedure will also be adopted next season, with the approval of the Board of Revenue, in the survey of the Javadi hills, where the conditions are the same.

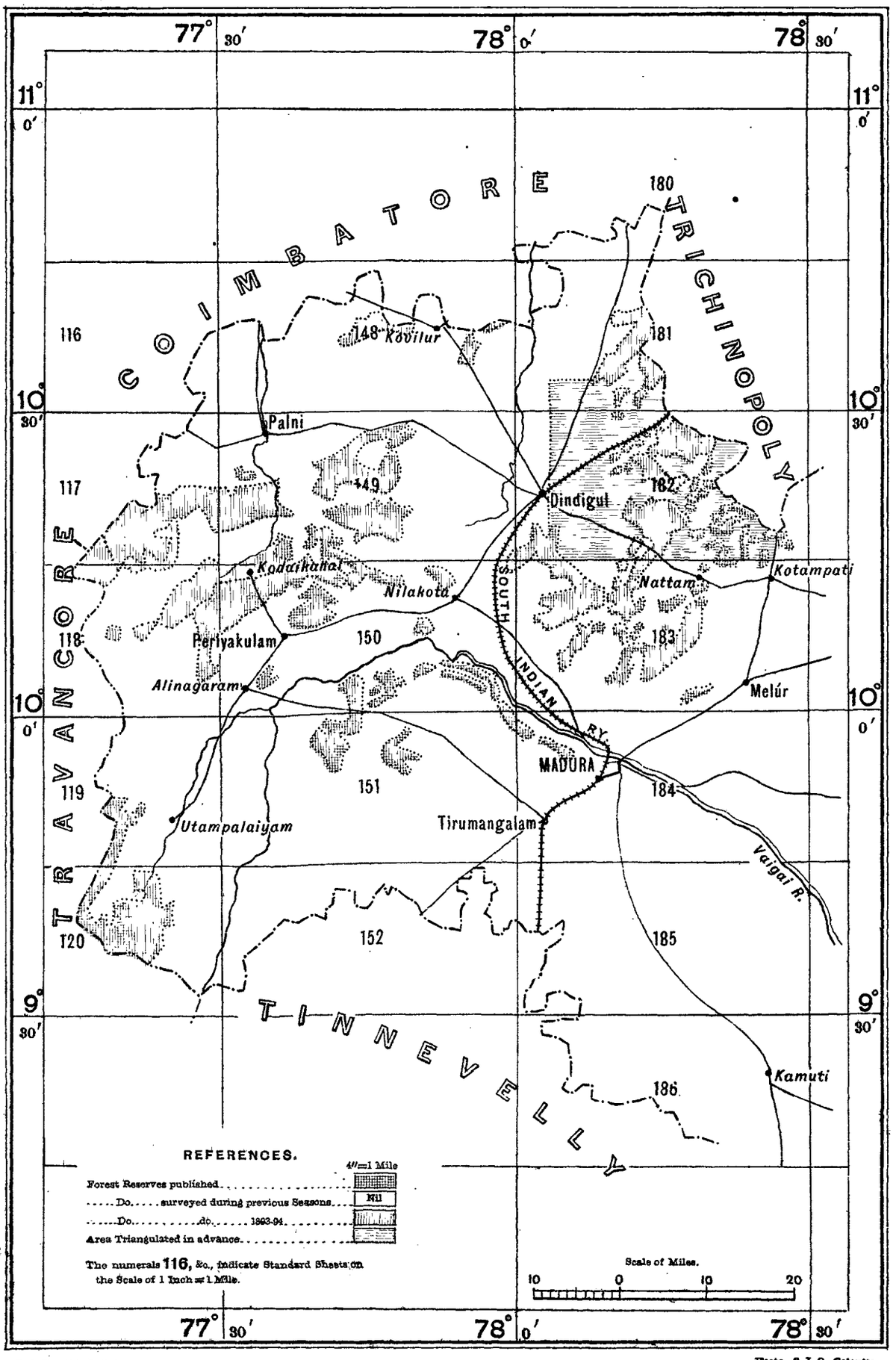
160. The whole of the work was examined by the Deputy Superintendent during its progress, and each plane table was tested by the section officer concerned by chain measurement, or *in situ* examination, as was found most suitable.

161. During the recess, the various computations have been brought up to date and the fair mapping completed, with the exception of the insertion of several boundaries which were found to have been wrongly demarcated. This entails a good deal of resurvey and the holding back of 12 sheets. The mapping is included in 62 sheets, and comprises 18 detached reserves and a large block of forests in the Kalrayan and Chitteri hills in Salem, 19 blocks of *shola* forests in the Palni hills, and 19 reserves in North Arcot.

162. The cost-rate of the survey again shows a diminution, being R5-6-9 per square mile less than that of last year, the rate for the year under report being R72-11-10 per square mile for triangulation, traversing, and detail survey.

MADRAS SURVEY.

1893-94. **INDEX TO THE FOREST SURVEYS IN THE MADURA DISTRICT.** No. 19 PARTY.



Reg. No. 406, S. I. D.—Jan 95.—550.

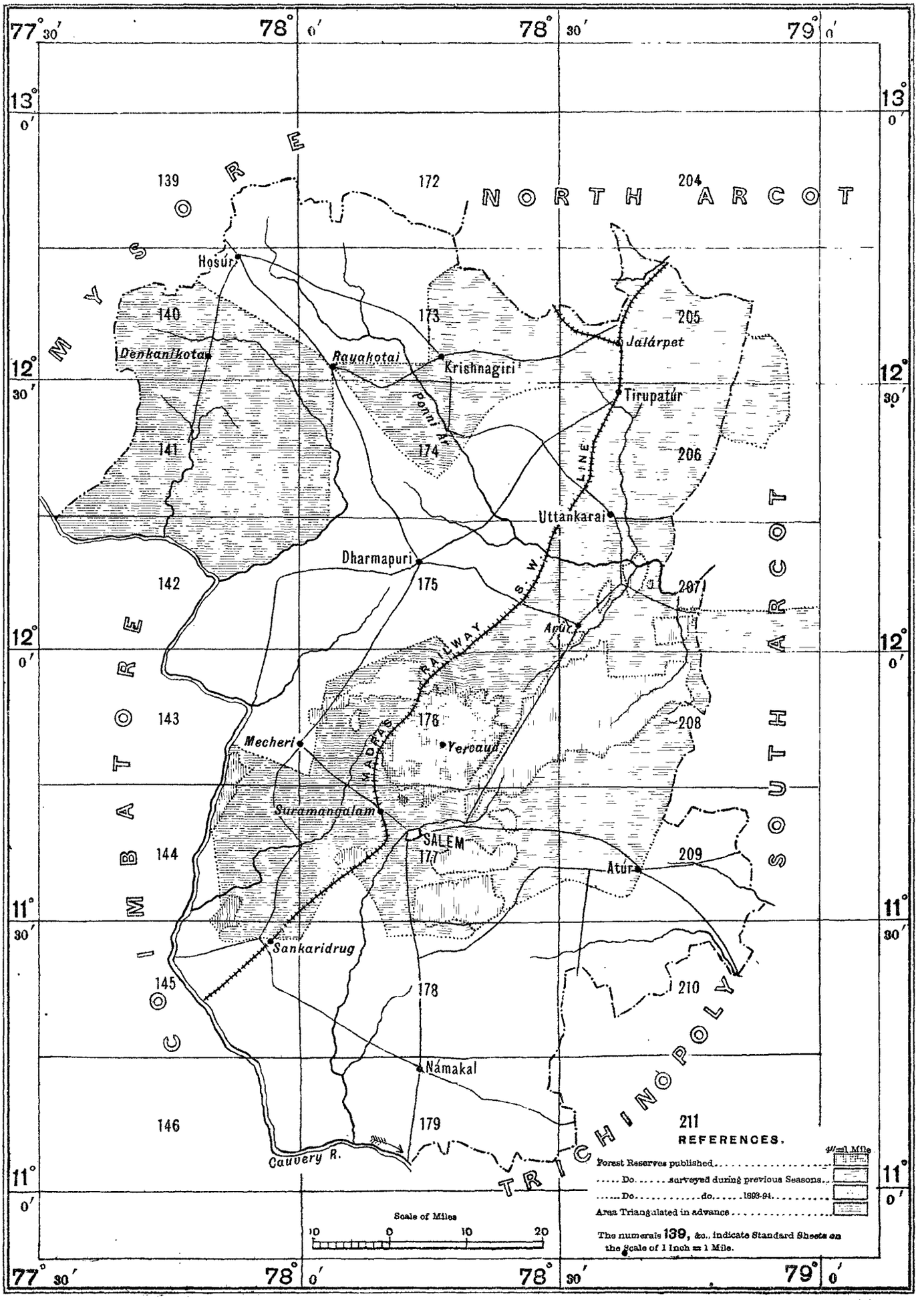
Photo., S. I. O., Calcutta.

No. 324-S. 95.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SALEM DISTRICT.

1893-94. No. 19 PARTY.



Reg. No. 406, S. I. D.—Jan. 95.—550.

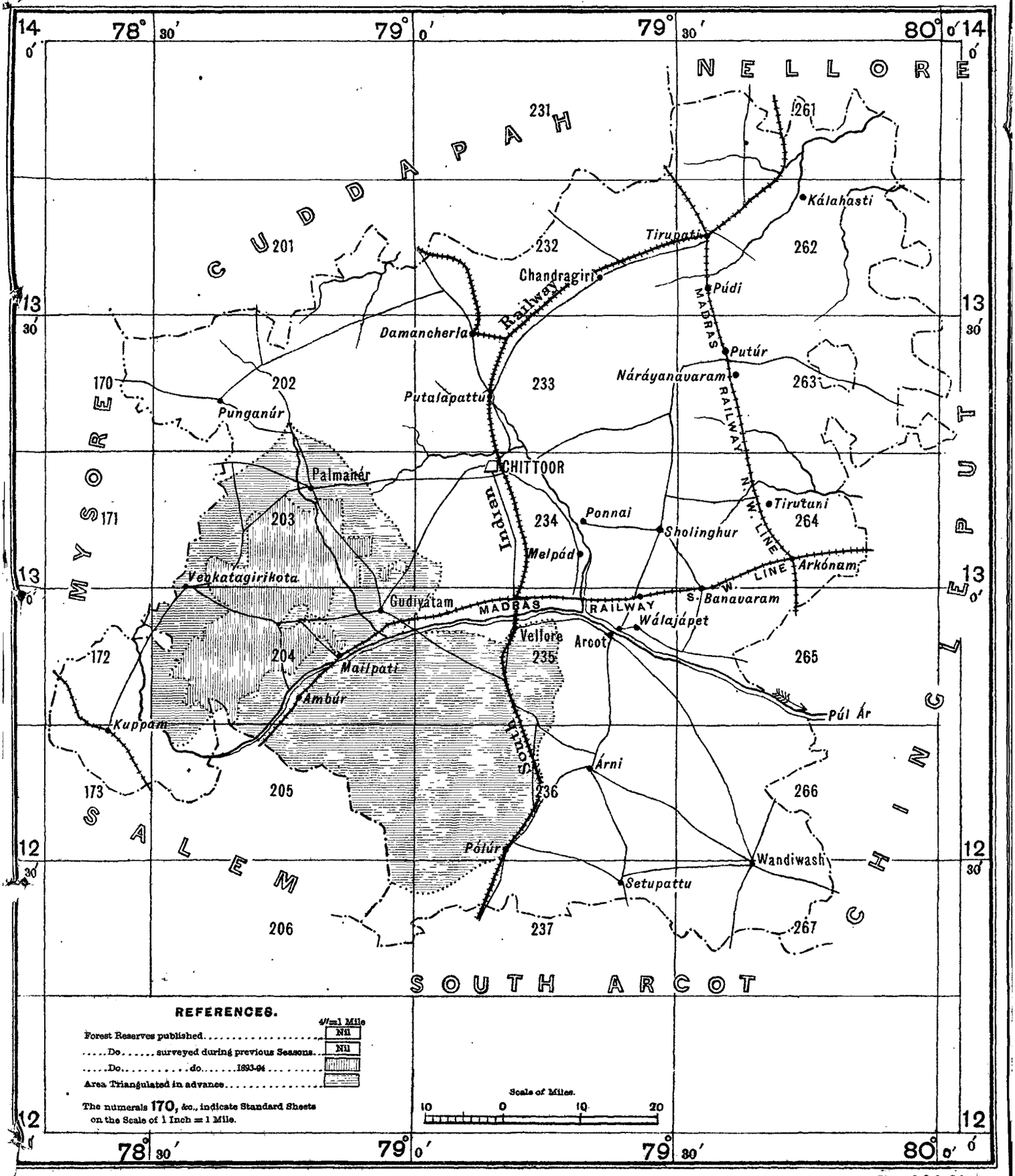
Photo., S. I. O., Calcutta

No. 327-S. 95.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE NORTH-ARCOT DISTRICT.

1893-94. No. 19 PARTY.



REFERENCES.

	4"=1 Mile
Forest Reserves published	Nil
.....Do.....surveyed during previous Seasons	Nil
.....Do.....do.....1893-94	
Area Triangulated in advance	

The numerals 170, &c., indicate Standard Sheets on the Scale of 1 Inch = 1 Mile.

Scale of Miles.

10 0 10 20

Reg. No. 406, S. I. D.—Jan 95.—850.

Photo. S. I. O., Calcutta.

No. 325-S. 95.

This diminution may be ascribed to the causes shewn above as leading to increase of out-turn of topography.

163. The recess office of the party was inspected by the Surveyor-General at Bangalore in September 1894 and found to be in a thoroughly efficient state, reflecting credit on the executive officer and the assistants in charge of the different sections.

164. The programme for the ensuing field season, approved by the local authorities, comprises the extension of the triangulation (in North Arcot chiefly) and the continuation of the detail survey in the Salem and North Arcot districts.*

LOWER BURMA.

NO. 20 PARTY.

165. The programme of the party consisted of the triangulation and traverse survey of the forest reserves of the Hanthawaddy district, comprising the Okkan Magayi, Hlanig Yoma, Thabyu, Kyun and Wanetchaung reserves. In addition to the above, the Paunglin reserve of the Pegu district was triangulated and partially completed in traverse. The detail survey operations on the 4-inch and 2-inch scales were carried on in continuation of the previous season's work at the northern extremity of the Toungoo district.

Personnel.

Mr. G. H. Cooke, Officiating Superintendent, 2nd grade, in charge from 7th November 1893.
„ W. A. Wilson, Extra Assistant Superintendent, 1st grade.
„ P. White, Extra ditto ditto 6th grade.
„ R. F. Warwick, Sub-Assistant ditto, 1st grade.
„ A. Ewing, ditto ditto 1st grade.
„ H. A. Charrier, ditto ditto 2nd grade.
31 surveyors and sub-surveyors.

166. The party left recess quarters at Bangalore in the middle of November 1893 and proceeded to Toungoo, which was made the field head-quarters. Mr. Wilson had charge of the traverse section and Mr. White carried out the triangulation in the reserves selected for survey in the Hanthawaddy and Pegu districts, while Messrs. Warwick and Ewing supervised the detail survey squads employed in the Toungoo district.

167. The traverse and detail surveys were commenced during the first week in December 1893 and continued until the end of May 1894, when the field operations were closed a little earlier than was intended, on account of the unusually early setting in of the rains in the middle of April, which considerably retarded the work. The 4-inch survey of the forest reserves of the Toungoo district was, however, completed and tested before leaving the field, but a small area of about 12 square miles of 2-inch work of unreserved lands lying adjacent to and between the forest reserves, had to be left unsurveyed.

168. The out-turn of the season consists of 420 square miles of triangulation, the same amount of traversing, and 426 square miles of detail survey, of which 282 is on the 4-inch and 144 square miles on the 2-inch scale. The aggregate area of detail survey completed exceeds that of the previous year by 81 square miles. The triangulation was carried on *pari passu* with the traverse survey and covered the same area of ground, in sheets Nos. 273, 279 and 280. The area traversed was divided into blocks of about 5 square miles each. The traverse lines were connected with 8 trigonometrical stations and the angular work was checked by 90 azimuths taken to the sun, as it was found to be almost impossible to obtain observations to stars at night. The sun azimuths, however, proved well and gave satisfactory checks.

169. The detail survey was carried on in sheets Nos. 224, 225, 271 and 318. The following forest reserves came under survey and were completed, *viz.*,

* Major Wahab reports very favorably on the European Assistants during the field season, and his remarks are fully endorsed by Captain Jackson who had charge of the party during the recess. Mr. Hamer succeeded in turning out the largest area of topography as yet attained to in this party, in spite of the work being a good deal scattered. Mr. H. Todd is commended for an out-turn nearly as large of difficult ground thoroughly well executed. Mr. R. Todd is commended for the judgment and accuracy with which he has carried out the triangulation of a difficult piece of country. The surveyors and sub-surveyors are with a few exceptions well spoken of, special mention being made of Raghavayengar, Tiruvenkatasami, Balaji Dhondiba, Anantarao Dhondiba and Govind Mukund. Surveyor Lachman Jadu who rejoined during the recess did good service as usual with the fair mapping. The Hospital Assistant J. Nathaniel David, and the Writer C. Papiah are also very well reported on.

Binbyi, Myohla, Saing Yeui, Yetkanzin, Sabyin, Lonyan and Kyakmasi, aggregating an area of 282 square miles on the 4-inch scale. The unreserved forest lands, lying between and adjacent to the reserves, amounting to an area of 144 square miles, were mapped on the 2-inch scale. The above areas were checked by the European assistants by 170 linear miles of test survey as well as by examinations *in situ*. The average proportion of these check lines is one mile to each $2\frac{1}{2}$ square miles of detail survey.

Two European assistants were employed entirely in supervising the work of the native surveyors, visiting them all in turns and testing the field plans. The executive officer also visited the men in the field whilst engaged at their work on the spot. The result has been a careful and accurate out-turn of topography.

170. The demarcation of the forest boundaries, with one or two exceptions, was found to be very good, and little or no difficulty was experienced in tracing them on the ground. The method of marking the boundaries was by building pillars at all salient points and at junctions of the forest reserves and by blazing certain trees along the lines between and nailing small boards on the trunks about 15 feet from the ground, bearing the usual forest marks or numbers in the Burmese character. The rough sketch maps provided by the Forest Department were used as guides in tracing the limits of the different reserves on the ground, and these were found to answer the purpose remarkably well. In any cases of doubt the forest guard was called upon to accompany the surveyors and to point out the exact lines.

171. The cost-rates of the different kinds of work performed are as follows:—

	₹	a.	p.
Triangulation	35	7	7
Traverse survey	128	12	3
Detail survey, on 4-inch scale	153	2	11
Detail survey, on 2-inch scale	83	10	9

The rates of the two kinds of detail survey are less than those of last year by ₹47 and ₹17, respectively, owing to the larger area completed. Still these rates are undoubtedly high, and at first sight contrast very unfavourably with the cost-rates of parties working in India; but it must be remembered that there are several extra causes of heavy expenditure which must be incurred by this party, over and above the nature of the country, which is undoubtedly much more intricate and clothed with far heavier jungle than any which falls to the lot of the surveyor in India. The most important of these are as follows. (*a*) the cost of importing field hands from India, (*b*) the pay of the much larger establishment of *khalásis* required for the clearing of jungle and carrying of provisions, and (*c*) the higher salaries paid to all employed. The total absence of local labour, the absence of all villages, except small hamlets, and the high rates of wages prevailing in Burma, necessitate all this extra expenditure. It has been calculated that these causes cost the following sums:—

	₹
(*a*) Cost of importation of field hands	12,000
(*b*) Pay of extra hands	14,900
(*c*) Difference between Burma and Indian salaries	20,000
TOTAL	46,900

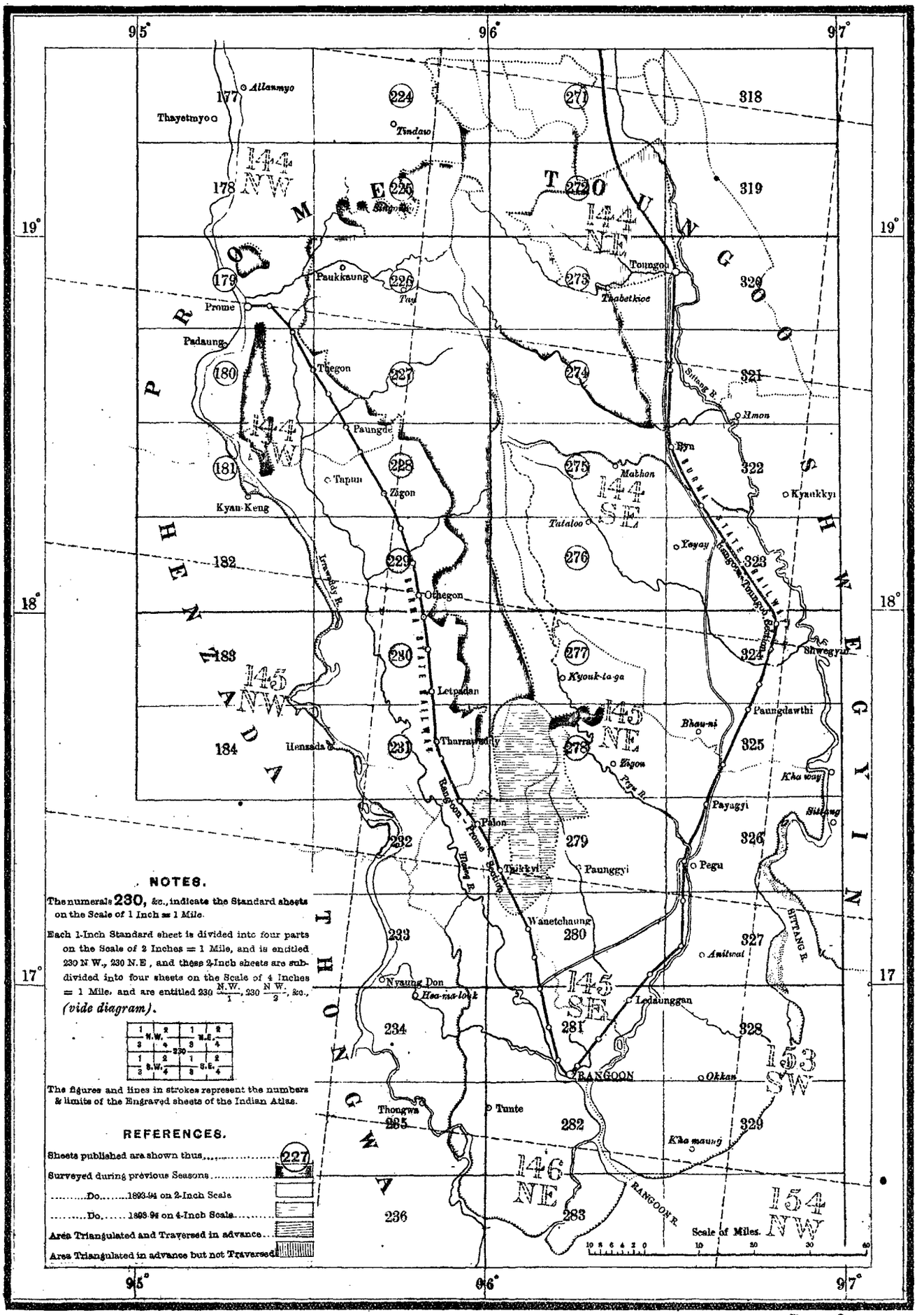
172. The following statement shows the cost-rates in Lower Burma afte deducting the cost of the above items and the average cost-rates for the same year incurred in the Forest Survey parties employed in India:—

	Lower Burma.	India.
	₹	₹
Triangulation	22	13
Traverse survey	80	15
Detail survey, 4-inch scale	95	78

It will be seen that the greatest difference lies in the cost of the traverse survey which is exactly what might have been expected from the difficult nature of the country, as the delay and consequent expense tells even more heavily on hose operations than on the detail survey. Considering the intricate character

BURMA SURVEY.

1893-94. **INDEX TO THE FOREST SURVEY IN LOWER BURMA.** No. 20 PARTY



NOTES.

The numerals **230**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are subdivided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 230 $\frac{N.W.}{1}$, 230 $\frac{N.W.}{2}$, &c., *(vide diagram)*.

1	2	1	2
3	4	3	4
N.W.		N.E.	
230			
1	2	1	2
3	4	3	4
S.W.		S.E.	

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus..... 227

Surveyed during previous Seasons.....

.....Do.....1893-94 on 2-Inch Scale

.....Do.....1893-94 on 4-Inch Scale.....

Area Triangulated and Traversed in advance...

Area Triangulated in advance but not Traversed

Reg. No. 462, S. I. D.—Feb 95—350.

Photo. S. I. O., Calcutta

No. 338-S. 95.

of the hills, the uniformly dense forest over the whole country and the expensive transport, the differences in the rates in the two countries appear to be quite justified.

Economy is exercised over every branch of the survey operations, and the only satisfactory way of reducing the cost-rates would be by increasing the subordinate establishment so as to obtain larger out-turns, but this would increase the total cost of the party; care, however, must be taken, if this be done, that the number of field hands does not become greater than can be properly supervised by the European staff. It is true that both the total cost and the cost-rates of the work might be lessened by reducing the European supervision, but this is not advisable, as experience has shown that in such a country native surveyors, and more especially Burmans, are tempted to shirk their work even to the extent of inserting imaginary topographical details in places there they think they will not be found out.

173. The country over which the survey operations have been carried this season, is about as bad from a surveyor's point of view as it well could be. It comprises a mass of low hills, but the hills being almost all about the same height, with few, if any, commanding points, it is very difficult to find suitable places for trigonometrical stations, and when found, they have to be cleared of trees of huge size. The traverse survey also necessitates a great deal of laborious clearing through low and tangled brushwood, and is further complicated by the difficulty of obtaining correct measurements with the chain owing to the hilly nature of the ground and by the numerous stations and short lines necessitated by the impossibility of seeing to any distance. The detail surveyor similarly has to cut his way everywhere and has in most cases to trust to sound rather than to sight to give him the direction of his forward flag. Day by day this weary task drags on and, doing his utmost, he finds at the end of the month that he has barely accomplished 3 square miles of country. With all these difficulties to contend with it is not to be wondered at that the work is slow and costly.

174. During the field season eight deaths occurred among the measurers. Fever, spleen, pneumonia and itch were prevalent throughout the field season, and most of the casualties recorded were due to general debility from the effects of malarious fever and enlarged spleens. The supply of water in the district during March and April was very scarce, especially on and near the Yoma range of hills, no rain having fallen in Lower Burma up to the middle of April; the monsoon rains then set in in torrents, and necessitated the withdrawal of the party at the end of May.

175. During the recess months, 30 standard sheets on the 4-inch scale were drawn. Six of these, containing the Gwethe Binbyi reserve on the left bank of the Sittang river, were finished and submitted to Calcutta early in September last for publication, as they are urgently required by the Forest Department to enable them to mark off the limits of their working plans for season 1894-95. The following reserves, *viz.*, Myohla, Saing, Yeni, Yetkauzin, Sabyin, Lonyan and Kyaukmasi have been fair mapped on 24 standard sheets or portions of sheets, and 20 of these have been submitted for publication whilst 4 have been retained in office for further additions. All the above reserves are contained in sheets Nos. 224, 225, 271, 272, 318 and 319, as shown on the index map. The computations of the traversing and triangulation have been brought up to date, and the skeleton blocks have been plotted on the 4-inch scale for the detail surveyors for the next field season.

176. The programme for season 1894-95 as approved of by the Conservator of Forests and sanctioned by the Chief Commissioner, is as follows. The triangulation and traverse survey of about 500 square miles of country in sheets Nos. 274 and 275 comprising the whole of the Pyu Kun reserve and a portion of the Aingdon Kun reserve, with a narrow strip of unreserved forests adjacent to them. The detail camp will operate in the area that was traversed this season in the Hanthawaddy district comprising the Okkan, Magayi, Hlaing-Yoma, Thabyu Kyun and Wanetchaung reserves, and a portion of the Paunglin reserve of the Pegu district will also be taken up if time permits. The area of the above consists of about 420 square miles, all of which will be surveyed on the 4-inch scale.

177. The Deputy Surveyor-General, Revenue Branch, inspected the field office of this party at Toungoo on 18th March 1894, after which, accompained by the executive officer, he made a short tour of inspection through some of the forest reserves, visiting and testing the board plans of some of the survey ors on the ground; he expressed his approval of the quality of work that he saw; and fully corroborates what the Deputy Superintendent says about the difficult nature of the country. The recess office at Bangalore was inspected by the Surveyor-General in September 1894. The general progress made in the mapping and computations was found quite satisfactory.

178. The Deputy Commissioner, Major Grey, and the Forest Officers are to be thanked for the cordial aid rendered to the survey on all occasions when it was asked for. The Deputy Conservator, Mr. Corbett, gave much assistance in obtaining the correct orthography of the Burmese names of streams, villages, etc.*

OPERATIONS OF THE FOREST SURVEY BRANCH.

179. The work executed by the Forest Survey Branch has not hitherto been included in the General Report of the Survey of India Department, as that branch is under the administration of the Inspector-General of Forests, and, until lately, the establishment appertained to the Forest Department. The administration still remains in the hands of the Inspector-General of Forests, but the officers have been brought into the cadres of the Survey of India Department. It was, therefore, considered that it would be convenient if a review of the operations were to find a place in future in this report, and under instructions from the Goverment of India it is now incorporated.

180. The branch is under the superintendence of Mr. W. H. Reynolds, Superintendent of Forest Surveys, and Deputy Superintendent, 1st grade, Survey of India, who has held the post since February 1887. The operations, in each province on which the branch has been employed during the year, are reported on separately.

CENTRAL PROVINCES.

181. In the Central Provinces, four detachments were employed upon the survey of forest reserves during the year. The forest divisions operated in by each detachment were—

Personnel.

Mr. E. Litchfield, Assistant Superintendent, 1st grade, Nagpur detachment.
„ T. S. Marten, Extra Assistant Superintendent, 6th grade, Narsinghpur detachment.
„ J. Marten, Sub-Assistant Superintendent, 1st grade, Raipur detachment.
„ C. Litchfield, Sub-Assistant Superintendent, 3rd grade, Balaghat detachment.

(1) Narsinghpur.
(2) Raipur.
(3) Balaghat.
(4) Nagpur, with Seoni and Chhindwara.

Each of these was under the immediate supervision of an European assistant, as shown above.

182. The several survey detachments took the field on various dates between 9th November and 9th December 1893, and closed work in June 1894.

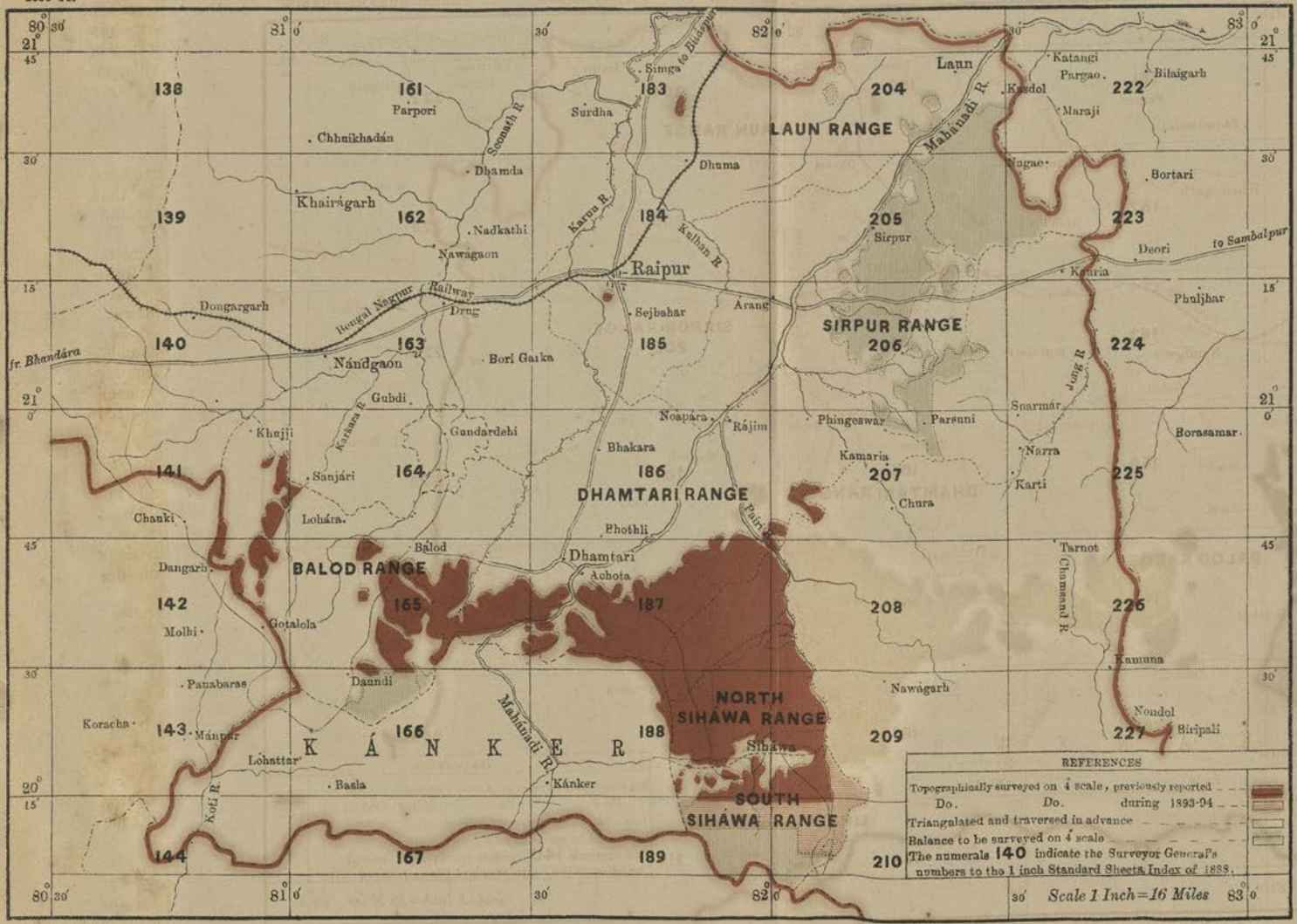
183. The survey of the reserved forests in Narsinghpur, Raipur, and Balaghat was in continuation of the operations of the previous year. The operations in the Sátpura range, extending through Nagpur, Seoni, and Chindwara, were commenced during the year under report, and were taken up by the detachment, which had completed the survey of the Goalpara forests in Assam, during the previous year.

*The Deputy Superintendent in charge reports that all the assistants have done good work. Mr. W. A. Wilson superintended the traverse camp, Messrs. Warwick and Ewing, the detail camps, and Mr. P. White carried on triangulation. The following members of the native establishment deserve to be commended: Venkatswamy, Amjad Ali, Sharfuddin, Mg. Hpo Nyen, Mg. Khan Nyen, Sultan Mohamed, Mohidin Beg, and Abdulla Khan.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN THE RAIPUR DISTRICT.

1893-94. FOREST SURVEY BRANCH.



Reg. No. 615, S. I. D.—Jan. 95—500.

Photo., S. I. O., Calcutta.

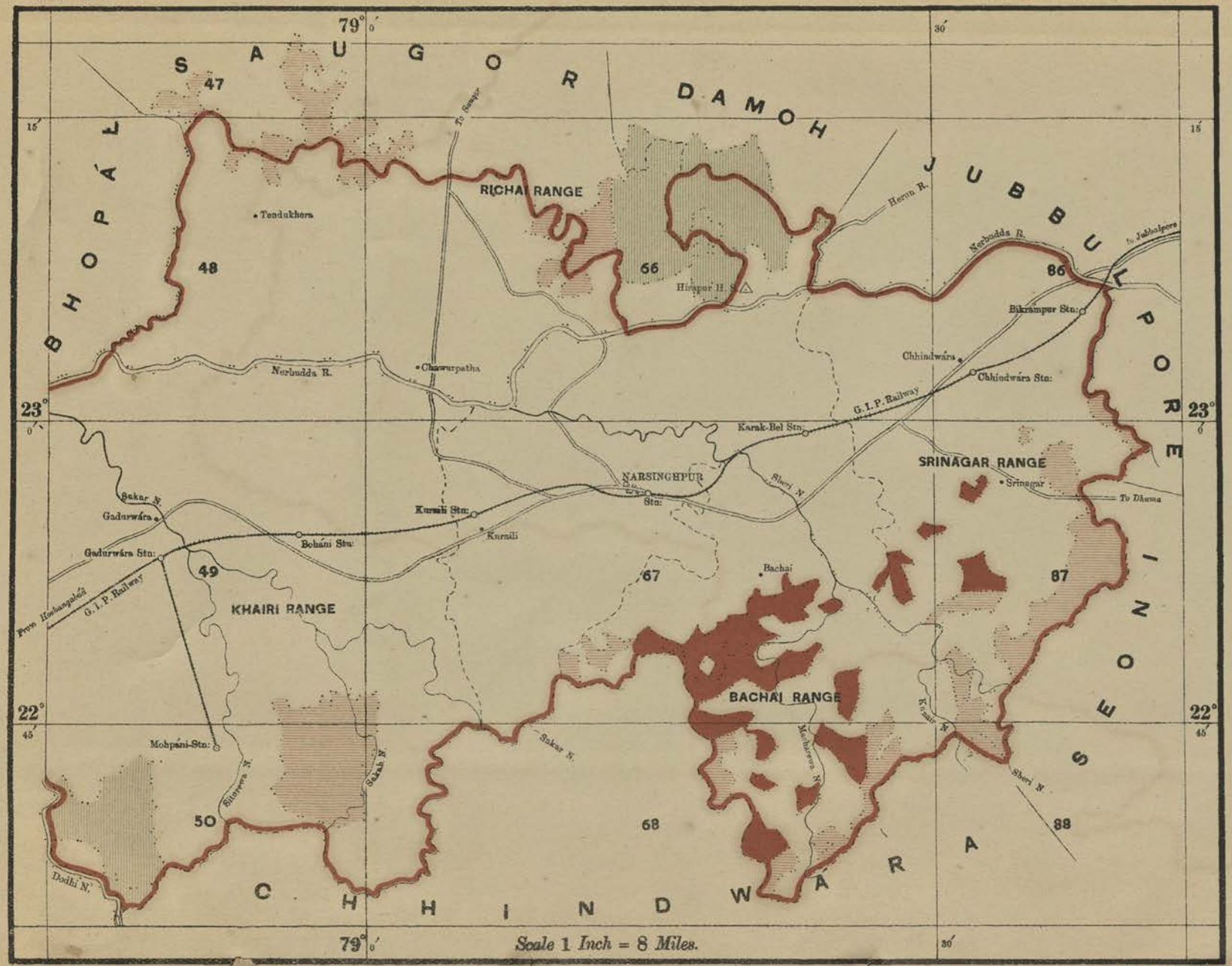
No 317-S 95.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN THE NARSINGHPUR DISTRICT.

1893-94.

FOREST SURVEY BRANCH.



REFERENCES.

Topographically surveyed on 4″ scale, previously reported.

Do. Do. during 1893-94.

Balance to be surveyed on 4″ scale.

The numerals **67** indicate the Surveyor General's numbers to the 1 inch Standard Sheets, Index of 1868.

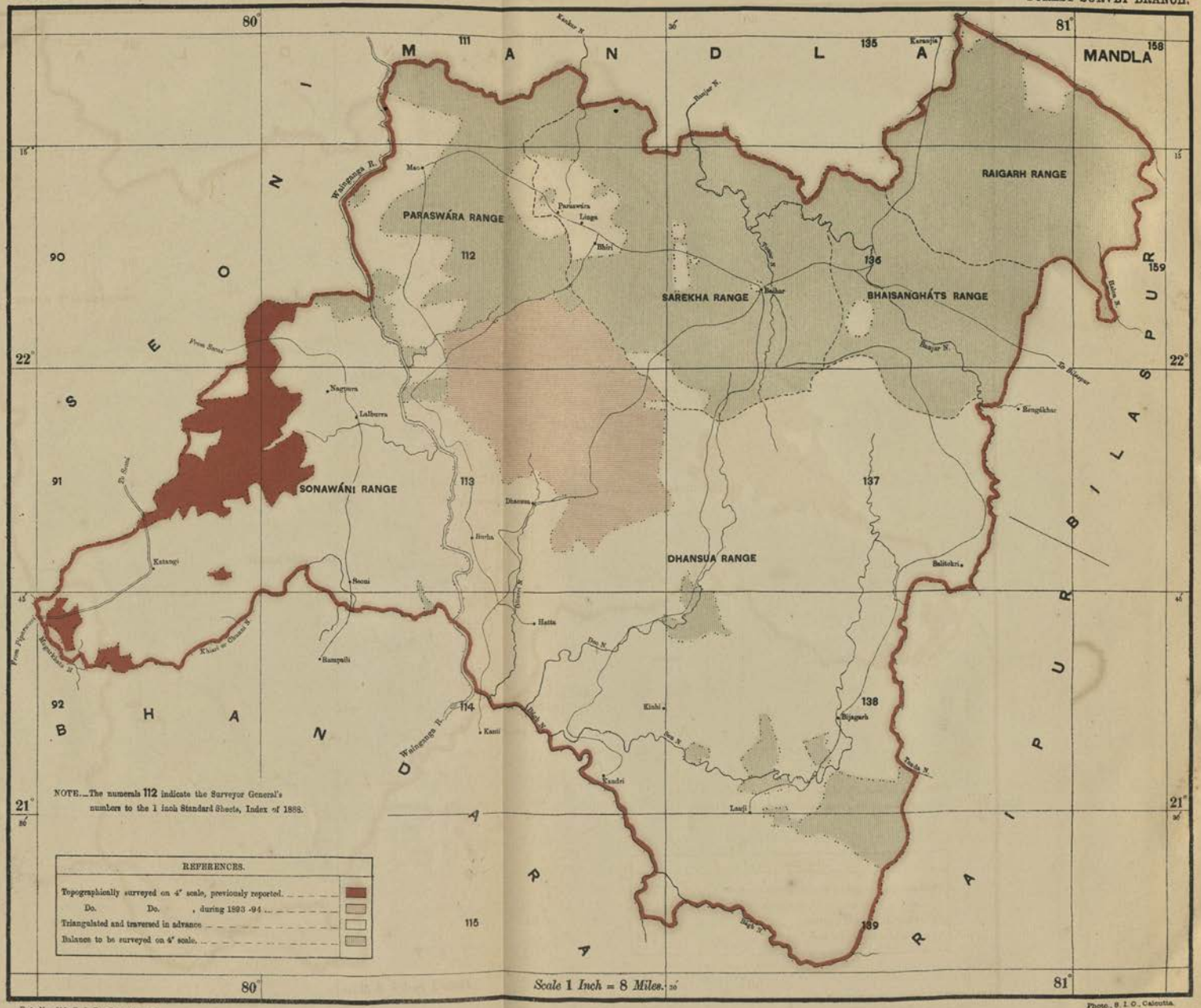
Reg. No. 615 S. I. D.—Jan. 95—550.

Photo., S. I. O., Calcutta.

No. 314-S. 95.

CENTRAL PROVINCES SURVEY.

1893-94. INDEX TO THE FOREST SURVEYS IN THE BALAGHAT DISTRICT, CENTRAL PROVINCES. FOREST SURVEY BRANCH.



NOTE.—The numerals 112 indicate the Surveyor General's numbers to the 1 inch Standard Sheets, Index of 1888.

REFERENCES.	
Topographically surveyed on 4" scale, previously reported.	
Do. Do. , during 1893-94	
Triangulated and traversed in advance	
Balance to be surveyed on 4" scale.	

Reg. No. 816, S. I. D.—Jan. 95—350.

Photo., S. I. O., Calcutta.

No. 316-S. 95.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN THE CHHINDWARA, SEONI, AND NAGPUR-WARDHA DIVISIONS.

1893-94.

FOREST SURVEY BRANCH.

Photo. S. I. O. Calcutta.

No. 318-S. 95.

184. The following statement shows the areas surveyed in each division and the cost-rate per square mile of each branch of the work:—

Forest Divisions.	Triangulation.		Levelling.		Topography, chiefly on 4-inch scale.	
	Area in square miles.	Cost-rate per square mile.	Linear miles.	Cost-rate.	Area in square miles.	Cost-rate per square miles.
		₹		₹		₹
Narsinghpur .	...	...	...	...	185	54·7
Raipur . .	...	...	52	16·7	165	65·7
Balaghat . .	256	6·8	...	...	184	40·1
Nagpur with Seoni and Chindwara..	1,072	5·4	...	...	174	56·0
Total areas .	1,428	...	52	...	708	...

185. Of the area surveyed in detail, 111 square miles were executed on the 16-inch scale along the forest boundaries, and 597 square miles on the 4-inch scale. The out-turn of the previous season was 80 square miles on the 16-inch scale and 482 square miles on the 4-inch scale.

186. In the Narsinghpur district no triangulation was done, as the entire forest area had been triangulated in the previous year, nor was any additional traversing required for any of the districts under survey.

The triangulation reported for Balaghat and Seoni and part of Nagpur was done by Mr. Nichol, and the balance of the triangulation in the Nagpur district was done by Mr. E. Litchfield.

In the Raipur district it was found necessary, for purposes of running instrumental contours, to carry on levelling operations in places where it had not been possible to fix a sufficient number of trigonometrical points.

187. The detailed survey was tested by running 175 linear miles of check lines through the work, and the instrumental contours that were run at 250 feet vertical intervals throughout the work in the Central Provinces also answered as checks on the topographical survey.

188. The expenditure on the above operations amounted to ₹47,276, and in addition a sum of ₹4,483 was expended in the Jubbulpur and Bhandara divisions, and ₹350 in the Chanda division, on account of drawing fair sheets and of printing and publishing cyanotype and photo-zincographed maps of the previous season's surveys, and an expenditure of ₹176 was incurred in the Saugor division for computations and plotting in advance of the field work, making in all a total expenditure during the year of ₹52,285, on account of surveys by the Forest Survey Branch in the Central Provinces.

The average cost-rate of the detail surveys, including the preparation of the classification of forests and soil records and mapping, but excluding triangulation and levelling, was ₹54, as compared with ₹50 last year.

189. As the surveys progressed, the 16-inch boundary records were compared with the settlement records, which are on the same scale, and the Settlement Officer's attestation to the accuracy of the boundaries was obtained.

190. All the detachments suffered more or less from malarial fever, and more particularly the surveyors employed in Balaghat and Raipur. From the circumstance of the Raipur forests that were operated in during the year being situated in remote parts (on the Madras border) and difficult of access, combined with the unhealthiness of the district, the cost-rate of the survey in the Raipur district has been enhanced.

191. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in the Central Provinces from the 5th February to the 4th March, and visited in turn each of the field detachments.

PUNJAB.

192. In the Punjab, the survey of the Bashahr State was resumed in continuation of the previous year's operations. The surveyors were in the field in October and November 1893, and again took the field in the summer of 1894 to undertake, on the 4-inch scale, a balance of scattered areas in the Chini and Pabar ranges which were left unfinished in the previous year, and this was completed; and, with the exception of a small tract in the south-east corner of the State, the 1-inch areas of the non-forest tracts undertaken to complete the survey of the Bashahr State have also been finished. This practically finishes the survey of the Bashahr State.

193. The topographical operations in the upper part of the State or in the Chini range were supervised by Mr. E. Litchfield, Assistant Superintendent, whilst the surveys in the Pabar range were tested by an experienced native surveyor; Mr. C. Litchfield also surveyed part of the 1-inch areas.

194. The following statement exhibits the areas surveyed during the year, and the cost-rates of the work:—

State.	Description.	Area in square miles.	Cost-rate per square mile.
			₹
Bashahr . .	Topographical survey, 4-inch scale . .	123	50·2
	Ditto 1-inch scale . .	287	19·3

195. The cost-rates for the previous year were—

Topographical survey, on the 4-inch scale . ₹59 per square mile.
Ditto do 1-inch ,, . 10.5 ,, ,,

The cost-rate of the 4-inch survey is lower this year, whilst that of the 1-inch survey is higher than in the previous year; the increased rate is chiefly due to the 1-inch areas operated on being situated at the extreme northern limit of Bashahr (touching on Chinese-Tibet) which is most difficult of access; and much time was spent in marching to and from the field, which also tended to increase the cost of the work.

196. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was with the Bashahr detachment from the 7th to the 28th May 1894, and personally supervised the field work in the Pabar range during that time.

OUDH.

197. The forest surveys in Oudh were in continuation of the operations of the previous year; the survey detachment left Dehra on the 7th November 1893, and field operations were commenced by the middle of the month; the field season was brought to a close on the 9th June 1894.

198. This detachment worked under Babu Oodey Sing, a skilled and trustworthy surveyor, and a man of considerable experience. The Superintendent visited the field party during the early part of the field season, and arranged the details of the field work, and he again visited the party a second time in April, or towards the close of the field season, and examined the field records and the check surveys that had been run through the topographical work of the several surveyors.

199. During the early part of the season, topographical work was confined to the forests in the Bhira forest range, which had been traversed during the previous year, but in December the surveyors moved into the Kheri forests,

PUNJAB SURVEY.

INDEX TO THE FOREST SURVEYS IN THE BASHAHR DIVISION.

1893-94.

FOREST SURVEY BRANCH.

REFERENCES

Bashahr Boundary				
Topographically surveyed on 4 scale				previously reported
Do.	Do.	on 1	Do	Do
Do.	Do.	on 4	Do.	during 1893-94
Do.	Do.	on 1		Do. 1893-94
Balance to be surveyed on 4 scale				
Do.	Do. on 1 scale			
Do.	Triangulated			

The numerals **350** indicate the Surveyor General's numbers to the 1 inch Standard Sheets. Index of 1888.

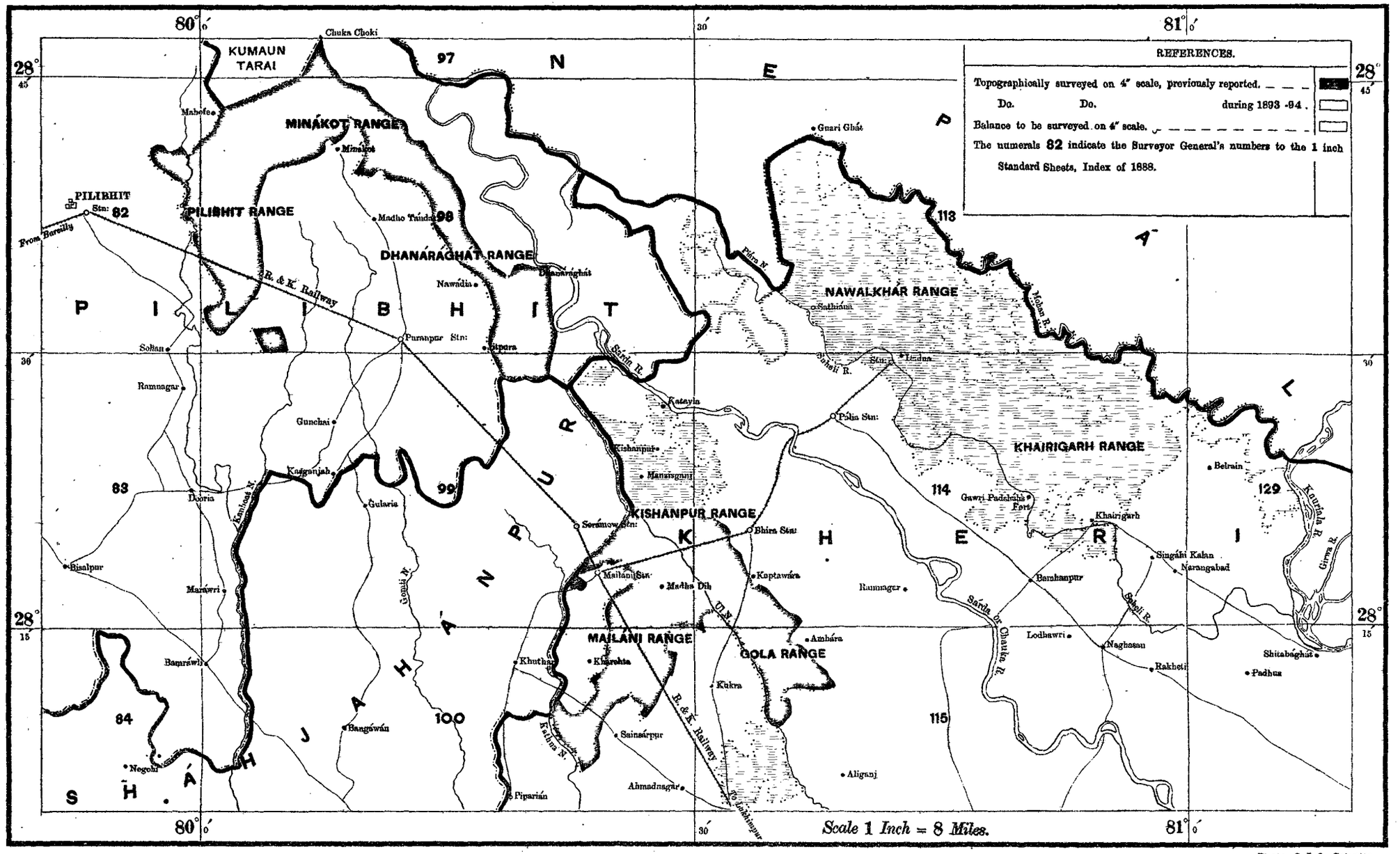
Reg. No. 616. S. I. D.—Jan. 95—950

Photo. S. I. O., Calcutta.

No. 315-S. 95.

OUDH SURVEY.

1893-94. INDEX TO THE FOREST SURVEYS IN THE KHERI & PILIBHIT DISTRICTS. FOREST SURVEY BRANCH.



Reg. No. 615. S. I. D.—Jan. 95—550.

Photo., S. I. O., Calcutta.

No. 313-S. 95.

where they continued to work until the close of the field season. Traversing was carried on in both the Kheri and the Gonda forests, the work in Gonda being in advance for the ensuing season's plane-tabling.

200. The following statement shows the season's out-turn, and the cost-rates of each class of work:—

Districts.	Traversing.		Levelling.		Topography 4-inch scale.	
	Area in square miles.	Cost rate per square mile.	Linear miles.	Cost-rate.	Area in square miles.	Cost-rate per square mile.
		₹		₹		₹
Kheri . . .	496	4·1	113	8·4	356	13·5
Gonda . . .			...	...	...	...
Total areas .	4·96	...	113	...	356	...

201. The total expenditure amounts to ₹13,167, in which is included a sum of ₹870 on account of drawing and other charges for maps of the Pilibhit forests which were surveyed in the previous year, and a charge of ₹4,500 for elephants purchased for the Oudh surveys. These two items appear to have been deducted from the expenditure before calculating the cost-rate. The low rates are due to the flat and easy nature of the country surveyed and to the fact of the work having been done without any European supervision.

202. Full use was made of all masonry tri-junction pillars in or near the forest tracts under survey, for which numerical data of previous revenue surveys were forthcoming. These permanent pillars or platforms were used as initial and closing points for the forest survey traversing, and the final results of the traversing were computed in the same terms as the Oudh Revenue Survey. This was done because it was not possible to triangulate the country, and there are no existing trigonometrical stations with which the traversing could be connected.

203. Spirit-levelling operations were undertaken with a view to ascertaining the best means of draining the *phantas* or extensive patches of grass-lands which are scattered throughout the *sâl* forests.

204. The country operated on in Oudh is flat and comparatively easy to survey, and no difficulties were experienced in obtaining labour and supplies and the health of the establishment was good throughout the season.

Burma.

205. In Burma, operations by the Forest Survey Branch were carried on in the Tenasserim Circle of Lower Burma, as well as in the Pyinmana district of Upper Burma, and were in continuation of the operations of the previous year.

206. The Tenasserim detachment, which was employed in surveying the reserved forests in the Salween division adjoining the Siam frontier, was under the orders of Mr. T. A. Hauxwell, Deputy Conservator of Forests, who attended to the supplying of provision and labour to the several surveyors' camps and supervised generally the work of the detachment whilst it was in his division.

Mr. C. E. Muriel, Deputy Conservator of Forests, supervised generally the detachment working in the Pyinmana districts.

207. Field work in the Pyinmana district and in the Salween division was commenced on the 13th and 20th November 1893, respectively, and the surveyors were in the field until the middle of May 1894.

208. The following statement shows the out-turn of work and the cost-rates of each class of survey :—

Forest Divisions.	Triangulation.		Traversing.		Topography 4-inch scale.	
	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.
		₹		₹		₹
Salween	...	...	...	...	112	83·3
Pyinmana	522	12·9	440	10 5	134	79 8
Total areas	522	...	440	...	346	...

209. No triangulation or traversing was done in the Salween division, as these branches of the work were well in advance of the topographical survey.

210. The average angular corrections on the traversing was 7 seconds per station. Two chains of unequal length were used for the linear measurement throughout, and all forest boundary pillars were utilized as traverse stations. The linear work was checked by connections with the trigonometrically fixed stations and the average error thereof was 3·3 per *mille*.

The detail survey was checked partly *in situ*, and partly by running 60 linear miles of check lines after the topography had been completed. A balance of detail work still remains to be done.

211. The Superintendent of Forest Surveys, Mr. W. H. Reynolds, was with the Upper Burma detachment from the 23rd December 1893 to the 15th January 1894, and saw that all branches of the work were fairly started, and after suitable points had been selected for the season's triangulation, and satisfactory arrangements made for provisioning each of the surveyors' camps, he proceeded to Lower Burma and inspected the work that was in progress in the forests on the Siam frontier, and was employed with the Salween detachment up to 30th January 1894.

212. Included in the cost-rate for triangulation in the Pyinmana district is a sum of ₹2,283, which was expended in the preliminary work of triangulation during the previous year, but against which no area could then be reported as the work was incomplete.

The cost-rate of the detail survey in the Salween division in the previous year was ₹81·7.

213. The traversing done in Upper Burma in 1893-94 is perceptibly cheaper than that of the previous year; this is due mainly to the fact that this branch of the work, for the year under report, was done entirely by native agency, and so also was the triangulation.

214. The cost-rates throughout are exceedingly low for Burma, but they cannot be accepted as a true criterion of the cost, because no charge whatever has been made for the services of the Deputy Conservators of Forests who supervised the general working arrangements of the detachments. The responsibility for the professional work was moreover entrusted entirely to low paid native surveyors, and thus there has been no expense in European superintendence whatever, which is the real cause of the low rates, but this is a measure which cannot be considered a sufficient means for obtaining accurate and reliable work, up to the standard of the Survey Department.

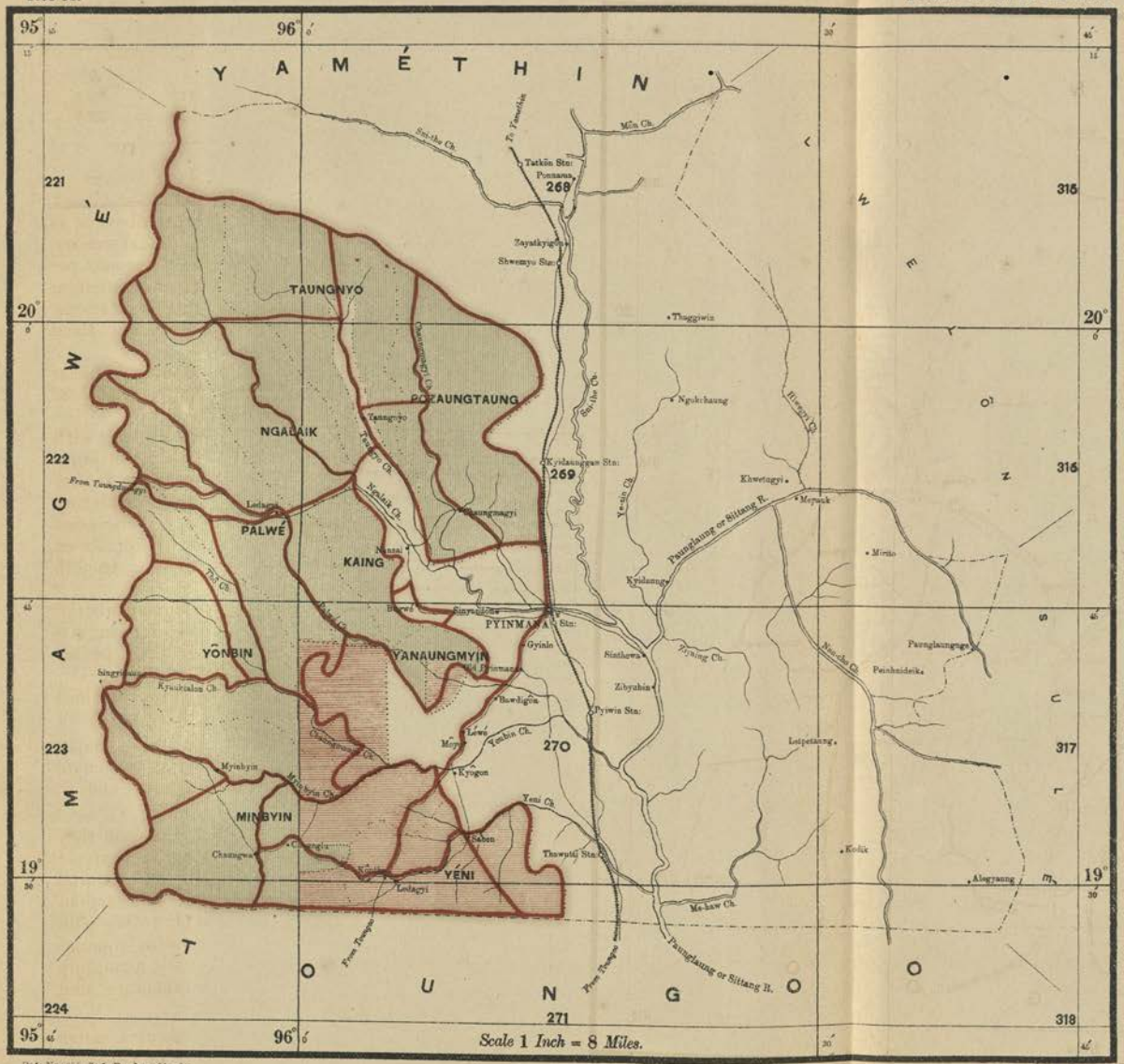
215. In addition to the operations described above, the services of a native surveyor were placed at the disposal of the Deputy Commissioner of Goalpara in Assam, to align and clear the Bhutan-Goalpara boundary, which had been demarcated during the previous year.

216. The Superintendent of Forest Surveys reports favourably on all his European assistants, and the majority of the members of the native establishment are said to have done good work. He considers that the good results of the year's out-turn of work are entirely due to the zeal, energy and steady application to their duties of both European and native establishments.

UPPER BURMA SURVEY.

INDEX TO THE FOREST SURVEYS IN THE PYINMANA DISTRICT.

1893-94. FOREST SURVEY BRANCH.



Scale 1 Inch = 8 Miles.

REFERENCES

Topographically surveyed on 4 Scale previously reported	
Do. Do. during 1893-94	
Triangulated in advance	
Traversed in advance	
Balance to be surveyed on 4 scale	

The numerals 270 indicate the Surveyor General's numbers to the 1 inch Standard Sheets, Index of 18[illegible]

Reg. No. 615. S. I. D.—Jan. 96—50.

Photo., S. I. O., Calcutta.

No. 312-S. 95.

BENGAL SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT SAR N.** Nos. 2 & 8 PARTIES.

Photo., S. I. O. Calcutta.

Reg. No. 470, S. I. D.—Jan. 95.—1,763.

No. 303-S. 95.

CADASTRAL SURVEYS.

BIHAR AND BENGAL.

NOS. 2 AND 8 PARTIES.

217. At the commencement of the year under report the establishment of No. 2 Party, which had been working in detachments scattered over Bengal and a portion of Bihar, was strengthened by the transfer of two cadastral sections from No. 8 Party in Orissa, the remainder of the Orissa party being constituted a detachment for the continuation of the operations in progress there. The two sections thus transferred to No. 2 Party were detailed for cadastral operations in Bihar; and the whole establishment, which was thus brought up to the strength of two ordinary survey parties, received the designation of Nos. 2 and 8 Parties. The operations in Bihar were under the superintendence of Lieutenant R. T. Crichton, S.C., while those in Bengal were supervised, as in the preceding year, by Captain J. M. Fleming, S.C.

218. The operations of the party comprised the following:—

(1) Cadastral survey in district Saran.
(2) Traverse and cadastral survey in district Champaran.
(3) Cadastral survey in the Tikari estates, district Gaya.
(4) Traverse and cadastral survey of the Chakla Roshnabad and Gangamandal estates, districts Tippere and Noakhali.
(5) Traverse and cadastral survey of the Palamau estate, district Palamau.
(6) Traverse and cadastral survey of the Jaipur estates, district Bogra.
(7) Traverse and cadastral survey of the Rajapur drainage area, district Hooghly.
(8) Traverse and cadastral survey of the Pataspur estates, district Midnapur.
(9) Traverse and cadastral survey of the Chaurasi estates, district 24-Parganas.
(10) Traverse and cadastral survey of the Burdwan estate, districts Hooghly and Burdwan.

The operations of each detachment will be described separately.

SURVEY OF THE SARAN DISTRICT.

219. The traverse operations in this district of the Patna division were carried out by Nos. 4 and 5 Parties, as in the preceding year, and will be found detailed in the report of those parties.

Personnel.
Mr. A. W. Smart Extra Assistant Superintendent, 6th grade.
Mr. C. S. Gasper, Sub-Assistant Superintendent, 2nd grade.
2 head inspectors.
20 inspectors.
108 imported *amins*.
99 local *amins*.

220. The cadastral operations were started by this party in the year under report. The establishment for the same was transferred from Orissa, and it commenced field work on the 8th November 1893, and returned to recess quarters on the 28th May 1894.

221. The following statement gives the areas surveyed and of which the records have been written in the several *parganas*:—

Parganas.	Cadastral survey, 16 inches = 1 mile.			Record-writing (Khanapuri).		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Kalyanpur Kuwari	1,036	623,155	431·4	1,006	590,763	411·3
Sipah	184	143,089	95·0	184	143,089	95·0
Pachlakh	40	44,473	22·6	39	42,720	20·7
Totals	1,260	810,717	549·0	1,229	776,572	527·0

222. The bulk of the villages surveyed belong to the Maharaja of Hatwa, who had decided that it was undesirable to test the non-professional survey of 1875 to ascertain if another survey was necessary and had preferred the preparation of new maps.

223. The average size of the field, calculated on the entire area surveyed and of which the records were written, is only 0·43 of an acre.

224. The area surveyed, which was mapped on 1020 sheets, was tested by 1,096 linear miles of check survey run by the European officers and by 1,405 linear miles by native inspectors, the total being 2,501 linear miles, which gives an average of 4·56 linear miles of test work to each square mile of survey. The number of entries tested by the European officers in the records of the fields was 1,161 and by inspectors 140,414, or a total of 142 025, which gives an average of 18 per cent. of the whole number of entries written. In addition to the above figures there were a number of entries checked by the Assistant Settlement Officers.

225. The 16-inch scale was used throughout, but it was invariably necessary to enlarge the village sites to the 64-inch scale on the margins of the field plans to admit of the numbering; and the areas of the minute plots contained within the village site have, in the majority of cases, been worked out to the third place of decimals of an acre.

226. The demarcation was renewed before detail survey by the inhabitants. It was found to be very good, and defective only where the boundary was under dispute. There were in all 192 boundary disputes, of which 190 have been settled. The greater number of disputes occurred amongst the Hatwa Raj villages *inter se* and were of a trivial character, generally regarding narrow strips of waste lands used as pathways. All such disputes were disposed of by the manager of the Raj by an arrangement made with the Settlement Officer.

227. All the records were completed with the exception of the *milan khasras* and crop statements, the preparation of which was stopped pending receipt of revised forms. The records of 90 villages containing 45,296 fields with an area of 29 square miles were made over to the Assistant Settlement Officer during the field season at his special request.

228. The Manager of the Hatwa Raj asked that he might be supplied, on payment, with the traces and copies of *khewats*, *khasras* and dispute lists of all villages of the Raj. This work was taken in hand by a large extra establishment during June. These copies are all stamped "uncertified," and are not signed by the Camp Officer, in accordance with the orders received, but this system of giving copies is to be deprecated.

229. The local *amins* employed, although they had been previously trained, were very slow at the commencement of operations, but improved greatly before the close of the field season. The *girdawars* of the Hatwa Raj were also a source of considerable trouble during the first two months of the season by sending in frivolous complaints. The attitude of the inhabitants for the first two months of the field season was one of passive obstruction, which was more or less due to the action of the Raj *girdawars*. When, however, the power of these *girdawars* was curtailed, the change in the attitude of the *rayats* was very marked and the attendance afforded both at the time of survey and *khanapuri* was excellent. In Saran, as in Champaran, the *birtdars* were very slack in their attendance, and the majority of process notices issued was against this class.

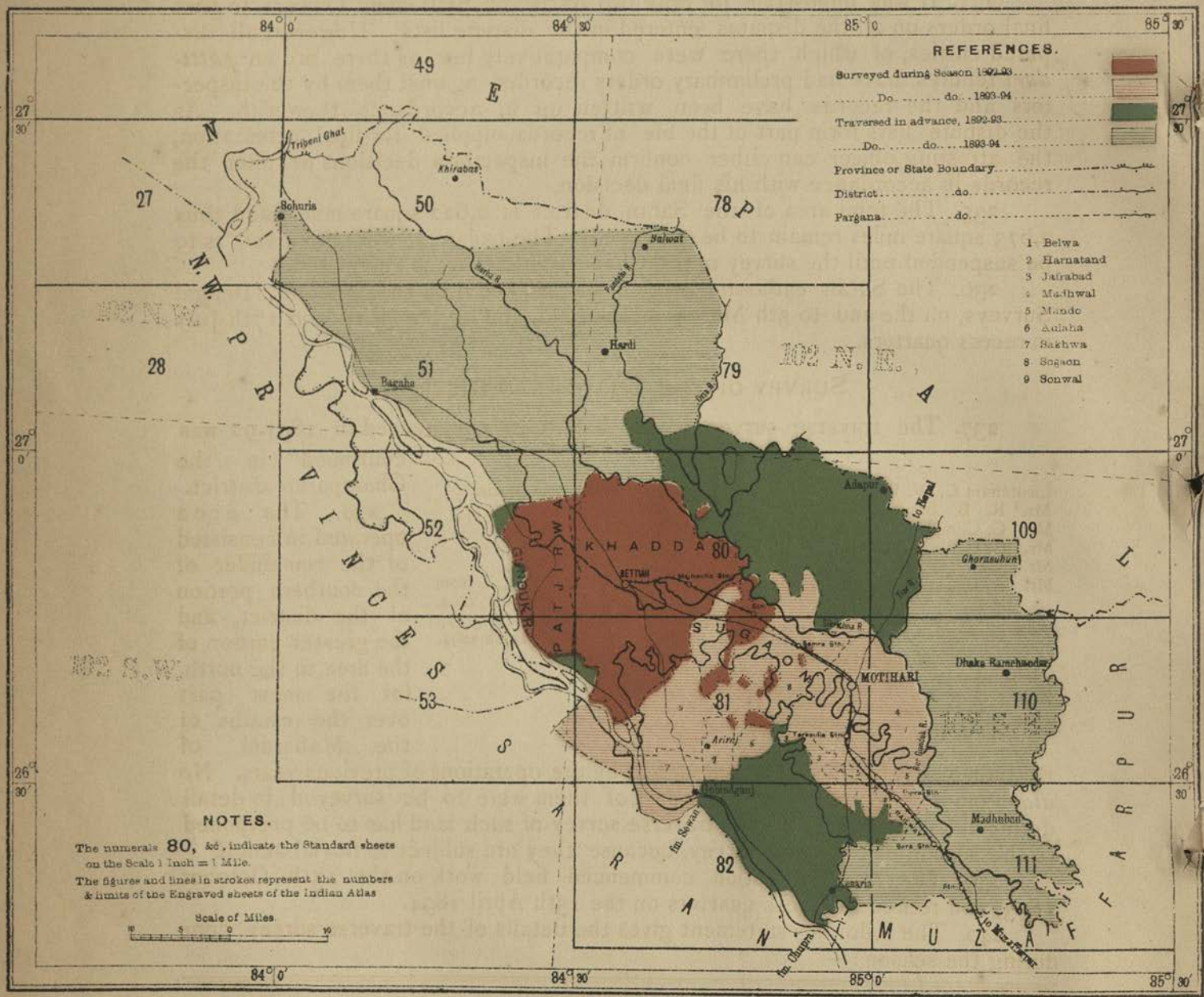
230. During the field season the health of the establishment was particularly good, but during the recess season there were several cases of fever and dysentery and two men died of cholera.

231. The expenditure during the season in this district was ₹65,200, of which ₹38,602 are debitable to detail survey, including completion of maps, areas, traces and instruction, and the balance, ₹26,538, to *khanapuri* and completion of records, the resulting cost-rates being, for detail survey, ₹70·4 per square mile, and for *khanapuri* ₹49·8 per square mile.

232. No labour was supplied free in this district. The three coolies supplied per *amin* were paid 1½ annas each per diem and the total actual expenditure on coolie bills has been ₹6,624. This amount is included in the expenditure for detail survey, but it represents in itself a rate of ₹12·1 per square mile.

BENGAL SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHAMPARAN.** Nos. 2 & 8 PARTIES.



Reg. No. 504, S. I. D.—Jan. 95.—1,752.

Photo., S. I. O., Calcutta.

No. 305-S. 95.

233. Of the *amins* employed 108 were imported and 99 locally trained. At the commencement of the season the following were the average daily outturns obtained from foreign and local *amins*:—

Foreign *amins*, 19 acres of survey, or 49 numbers of *khanapuri* a day.
Local do. 5 ditto 36 ditto.

Towards the close of the field season the averages obtained were as follows:—

Foreign *amins*, 40 acres of survey, or 66 numbers of *khanapuri* a day.
Local do. 20 ditto 58 ditto.

This is a very marked improvement in the local *amins*, and Mr. A. W. Smart and his assistants deserve considerable credit for their perseverance and patience in completing the training of the local men.

234. It was impossible for only two Assistant Settlement Officers to pass final orders on all the disputes entered in the dispute lists. However, all disputed entries, of which there were comparatively few as there are no *pattidari* tenures, have had preliminary orders recorded against them by the inspectors and the records have been written up in accordance therewith. As the dispute lists form part of the file of records supplied for final attestation, the attesting officer can either confirm the inspector's decisions or alter the records in accordance with his final decision.

235. The total area of the Saran district is 2,622 square miles, and thus 2,073 square miles remain to be surveyed. The cadastral work, however, is to be suspended until the survey of the Champaran district is completed.

236. The Saran cadastral section was inspected by the Director, Bengal Surveys, on the 2nd to 5th March in the field, and on the 16th and 17th July in recess quarters.

SURVEY OF THE CHAMPARAN DISTRICT.

237. The traverse survey which had been commenced in 1891-92 was continued in the Champaran district.

Personnel.

Lieutenant C. W. H.	Symons,	Assistant Superintendent,	2nd grade.	
Mr. R. B. Smart,	Extra	„	„	4th „
Mr. G. Campbell,	„	„	„	6th „
Mr. G. G. Vander Beek,	„	„	„	6th „
Mr. J. P. Barker,	Sub-	„	„	1st „
Mr. A. B. Smart,	„	„	„	2nd „ from 1st July 1894.
Mr. C. G. S. Wood,	„	„	„	2nd grade up to 31st March 1894.

28 surveyors and sub-surveyors.
2 head inspectors.
20 inspectors
79 imported *amins*.
127 local *amins*.

238. The area operated in consisted of the remainder of the southern portion of the district, and the greater portion of the area to the north, for the most part over the estates of the Maharani of Bettiah, which had been left untouched by the operations of previous years. No *diára* lands were traversed, as no part of them were to be surveyed in detail during the current season: the traverse survey of such land has to be postponed to the season of cadastral survey, because they are subject to fluvial action.

239. The traverse section commenced field work on the 15th October 1893, and retired to recess quarters on the 15th April 1894.

240. The following statement gives the details of the traverse survey done during the season:—

District.	Number of village and hamlet circuits.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Champaran . . .	1,554	2,627	35,766	1,320

241. The area traversed was divided into eight main circuits which followed the *pargana* or *tappa* boundaries. The total amount of new chaining was 5,937 linear miles.

242. The angular work was checked by observations for azimuth at 136 stations on the main and sub-circuits, at an average of 30 stations apart. The mean variation of the magnetic needle, calculated on the results of all the azimuths observed, is 2° 24′ 36″ East of the true north.

The linear measurements were checked by connections with eight stations of the Great Trigonometrical Survey. The error of the chaining in comparison with the direct trigonometrical distances is 8·0 feet per mile. This average is obtained from the computations of six direct distances.

243. Of the 27,120 new traverse stations, 25,945 have been permanently marked. Of these, 2,515 were at tri-junction points, at which 692 stones and 1,823 of the large cylinders were embedded, the balance of 23,430 stations being marked by small cylinders. In addition to the above, 1,175 stations on disputed lines were temporarily marked by pegs which will be replaced by the cadastral surveyor with tri-junction stones or cylinders when the disputes have been decided.

As the villages are of large size, it was decided that those of over 3 square miles in area should be divided for the purposes of the record, either by hamlets or by separate *jamabandis* where these comprise compact blocks, or by natural features.

244. In addition to the above out-turn it was found necessary to supplement the sub-traverses in the previous season's work by running 352 extra sub-traverses. The number of new stations, all of which have been marked by cylinders, is 1,564, and the linear miles of new chaining 435.

245. The preliminary demarcation, which was done by the inhabitants entirely, was found to be very good, and thus the line clearing squads were enabled to keep ahead of the sub-surveyors.

246. All the masonry pillars of the Nepal frontier were connected with, either by offsets or by triangulation. In addition to this, the traverse data of the Nepal boundary frontier survey, and the maps of the same, have been obtained, and as the boundary pillars will be shown on the traverse plots, there is no danger of any encroachments into Nepal territory.

247. The total expenditure on the traverse survey during the season, was ₹50,498, the resulting cost-rate being ₹ 38·3 per square mile. The rate is considerably higher than that of last year, but it includes the cost of completion of arrears of the previous season which were very heavy, and as little or no arrears remain of the present season's work, the future cost-rate will compare favourably with that of previous seasons.

248. The area to be traversed next season in district Champaran is 248 square miles, which is all that remains excluding the *diára* or riverain portions which will not be traversed till 1895-96, as the detail survey thereof will not be undertaken until that season, and it is essential that the detail survey should follow the traverse immediately in *diára* tracts, as the traverse marks are liable to be washed away. The area traversed in advance of the detail survey is now 1,855 square miles.

249. The traverse section was inspected by the Director, Bengal Surveys, in the field in February, and in recess in the beginning of August 1894.

250. *The Cadastral Survey.*—The section for the cadastral operations commenced field work on the 23rd October 1893, and returned to recess quarters on 30th April 1894. A small field establishment of one inspector and seven *amins* was out till the end of May in a small area which had been selected in order to give a trial to the late orders of Government regarding the preparation of preliminary rent-rolls by inspectors, and the writing up of the records in accordance therewith.

251. The area cadastrally surveyed this season is low-lying and intersected by two streams, the Dhanauti and Makwa, neither of which can be crossed except where bridged. It is immediately to the south of the area cadastrally surveyed last season, and falls approximately within the parallels of 26° 29′ and 26° 50′ north latitude, and the meridians of 84° 35′ and 85° 05′ east longitude. It consists for the most part of the estates of the Maharani of Bettiah.

252. Of the 304 villages of the current season's programme of which the records were written, 263 belong to the Bettiah Raj, which has also a share in 18 more, the remaining 23 only being *zamindári*.

253. The area surveyed and of which the records were written during the season, are given in the following tabular statement:—

District.	Cadastral Survey. 16-inches = 1 mile.			Record-writing (Khanapuri).		
	Number of villages	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Champaran	325	474,679	517	354	540.338	599

254. The 325 villages surveyed during the season were mapped on 779 sheets, but on account of their large size, the 354 villages of which the records were written were divided into 579 portions, the records of each being written separately.

255. The average size of the field, calculated on the entire area of which the records were written, is 0·71 of an acre.

256. The area surveyed was checked by 587 linear miles of test survey run by European officers and 1,087 linear miles by inspectors, which gives a total of 1,694 linear miles, or an average of 3·28 linear miles of check work to each square mile of survey. The number of entries in the field records tested by the European officers was 3,467 and by inspectors 90,638, or a total of 94,105, which gives an average of 18 per cent. on the total number of plots of which the records were written. These figures do not include the checking done by Assistant Settlement Officers.

The 16-inch scale was utilised throughout, except for the village sites. At the commencement of the season an attempt was made to survey the village sites also on the 16-inch scale, but it had to be abandoned, as it was impossible to show the houses distinct from their court-yards; therefore all village sites are mapped on the margins of the field plans on the 32 or 64-inch scale.

257. The demarcation which had been renewed entirely by the inhabitants was very good. No difficulty was found in following the boundaries except in the *diára* area in which there were several large disputes. There were altogether 72 boundary disputes, all of which were settled by the Settlement Department, but one of these decisions had to be returned, as the Assistant Settlement Officer who settled the dispute in question directed that the old revenue survey boundary as shown approximately on the trace, and which cuts through existing fields, should be the boundary, which makes *khanapuri* according to possession impossible. A similar case to this occurred in Gaya and has been pointed out to the Director of Land Records.

258. The copies of the Collectorate registers supplied by the Settlement Department were partly in English and partly in vernacular, and the registers of 49 villages were not supplied at all; therefore as regards these 49 villages, the *khewats* were written up from information obtained on the ground.

259. All the records, including the traces, with the exception of the *milan khasra* and crop statement, the preparation of which was stopped pending receipt of revised forms were completed. The *milan khasras* of 168 villages and crop statements of 185 villages remain for completion, which the Settlement Officer has undertaken.

260. The Manager of the Bettiah estates having asked for traces of all villages of the Raj, except those let out on *mukarrari* lease, these are under preparation by a separate establishment, all charges being met by the Raj, who will be charged according to the rates which may be decided on.

261. The following Indigo Concerns fell within the area surveyed, *viz.*, Tarkaulia, Motihari, Lalsaria, Pipra and Bara. The managers of all factories and out-factories assisted in obtaining the attendance of *rayats*, and Mr. R. B. Smart reports that he obtained valuable aid from the Managers of the Motihari and Pipra Concerns in obtaining copies of the *jamabandis* for the preparation of preliminary rent-rolls.

262. The greatest difficulty experienced throughout the season was in retaining the *amins*. Another cause of delay was the interference of the *girdawars*, or agents of the Bettiah Raj and indigo concerns. These men did not understand the survey procedure, and were constantly trumping up unnecessary reports. Th *rayats* exhibited indifference to the survey.

e 263. The total expenditure during the season on these operations was ₹7 ,494, of which ₹38,767 are debitable to detail survey, which includes completion of maps, areas, traces, and instruction, and ₹32,727 to *khanapuri* and completion of records; the resulting cost-rates being for detail survey ₹74·9 per square mile and for *khanapuri* ₹54·6 per square mile.

264. In only five villages were coolies supplied free. In the remainder of the area three coolies per *amin* were obtained, while the *amin* was employed on survey only. These coolies were paid at the rate of 1½ annas each, except at the commencement of the season, when the rate paid was 2 annas per coolie. The total expenditure on cooly payments was ₹6,358-13-9. This amount has been included under the head of detail survey, but without adding to this amount any charge for the general section, it represents in itself a cost-rate of ₹12-4-10 per square mile.

265. At the commencement of the season the following was the daily average out-turn obtained from foreign and local *amins* :—

Foreign *amins*, 16 acres of survey, or 29 numbers of *khanapuri* per day.
Local do. 7 ditto 17 ditto.

Towards the close of the season, when the establishment had gained more experience, the averages were as follows :—

Foreign *amins*, 21 acres of survey, or 38 numbers of *khanapuri* per day.
Local do. 20 ditto 45 ditto.

The great improvement in the local *amins* is very marked, and Mr. R. B. Smart deserves considerable credit for the same.

266. The total area of the Champaran district is approximately 3,575 square miles, of which 933 square miles have now been surveyed in detail. An area of 1,200 square miles is to be undertaken in the ensuing season.

267. The survey of Bettiah town, which was commenced during the field season of 1892-93, on the 64-inch=1 mile scale, accompanied by a register of occupancy area, etc., has now been completed, and comprises an area of 374·71 acres. The total cost of ₹732-0-4 has been met by the Raj.

268. During the season it was discovered that several entire villages and portions of others were included within the Motihari municipal boundaries. The Settlement Officer directed that the *khanapuri* of these villages should not be undertaken until the correct limits of the Municipality had been defined on the survey maps. This is being done, and the *khanapuri* will be done according to the orders of the Settlement Officer. Lieutenant Crichton reports "the map prepared by the Municipality was compared with the portions lately surveyed and found to be most inaccurate, but doubtless the Municipal Commissioners are aware of this."

269. This cadastral section was inspected by the Director, Bengal Surveys on 27th October 1893, on 20th February, and on 14th to 17th July 1894.

Survey of the Tikari Estates,

Gaya District.

270. The cadastral survey and settlement of the Tikari (Ward's) estates, district Gaya, was ordered in No. 1024 from the Bengal Government, dated 1st March 1893. The traverse operations were carried out by a detachment from Nos. 4 and 5 Parties and will be found described in the work of those parties.

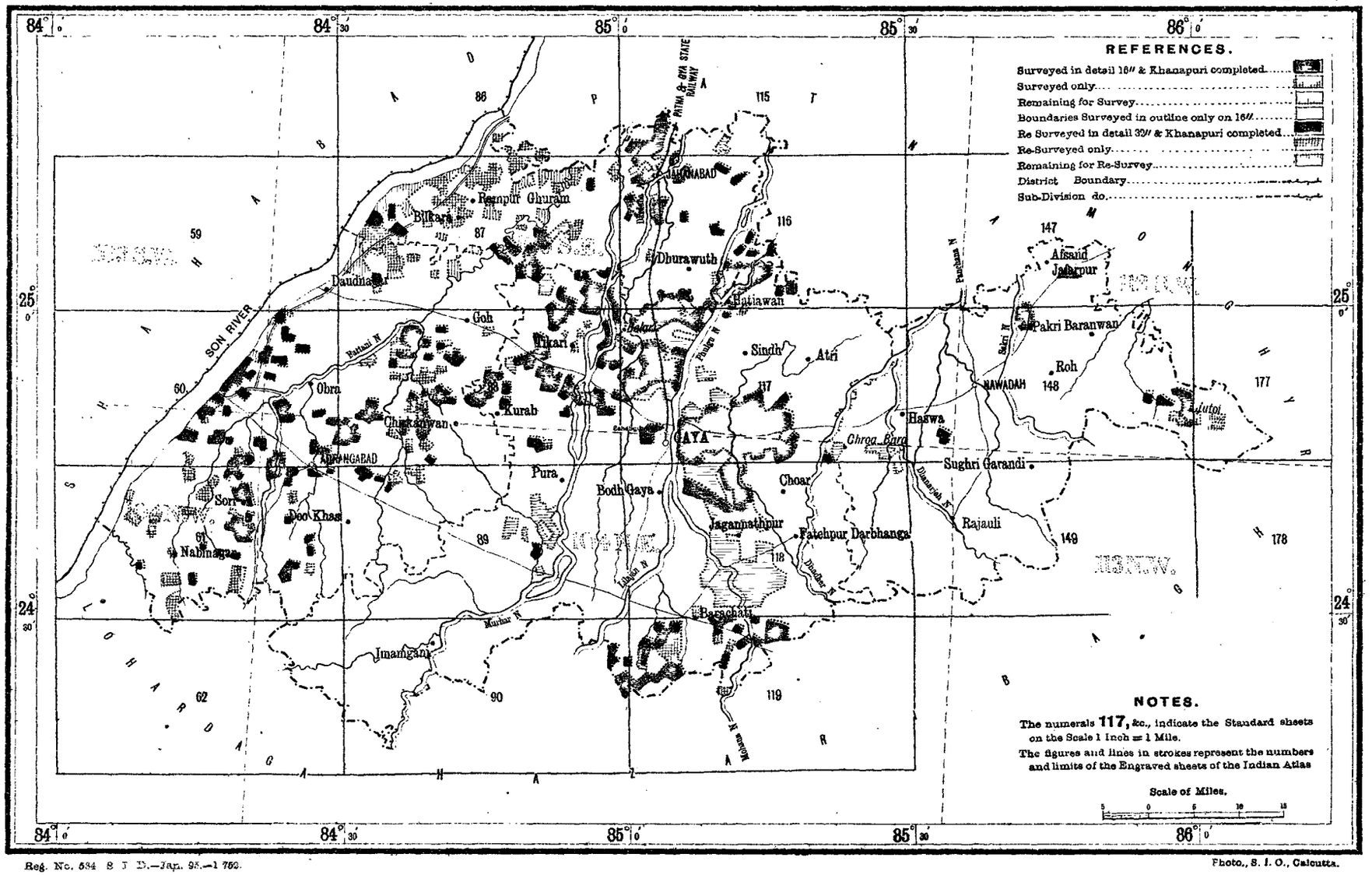
Personnel.

Mr. G. T. Hall, Extra Assistant Superintendent, 6th grade.
„ N. Bedford, Sub-Assistant Superintendent, 1st grade.
3 head inspectors.
18 inspectors.
96 imported *amins*.
64 local *amins*.

271. The section employed on cadastral survey was transferred from the Chittagong district. Field work was commenced on the 15th October 1893, and closed on the 15th May 1894.

BENGAL SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT GAYA.** Nos. 2 & 8 PARTIES.



Reg. No. 534 S. I. D.—Jan. 95.—1 762.

Photo., S. I. O., Calcutta.

No. 302-S. 95.

272. The area surveyed is scattered over the Gaya district. Two large blocks are situated—one to the north of Gaya city, and the other to the east and south-east thereof. The remainder of the area is in small detached portions, as a reference to the index map will show.

273. The original intention was to complete the cadastral survey of all the villages of the Tikari Ward's estate according to a list supplied by the manager during the season, and the estimates submitted were based on an area of 558 square miles as shown therein.

The following statement, which gives the number of villages and areas completed during the season, will show that the reported area of the estate has already been surpassed :—

	Number.	Area in square miles.
Sir and *thika* villages . . .	543	408
Mukarrari do. . . .	224	147
Irrigation area do. . . .	47	63
TOTALS .	814	618

In addition to this, it is known that there are still for survey 50 *sir* and *thika* (contract) villages covering 28 square miles, and 50 villages with an area of 64 square miles in the irrigation area ; also 22 villages, 7 square miles under *mukarrari* lease (held at a fixed and permanent rental). Adding these figures to the completed area will give 936 villages and 711 square miles as the extent of the Tikari possessions in Gaya. The areas remaining may be even greater than is anticipated, but, in any case, the number of villages has increased by 286 and the area by 161 square miles. This excess of 161 square miles cannot be partly accounted for by the 147 square miles of *mukarrari* area, as the Manager distinctly says, in his note of 6th April 1894, that the 352,146 acres contains *mukarrari* and all villages. Possibly the Manager did not include villages in which the estate is only part proprietor, and which under recent orders will be omitted from the survey, provided the estate's interest is less than 8 annas. It may be mentioned that on the discovery of any village the name of which did not appear in the map nor in the list received from the Manager, a reference was always made before the survey was taken in hand.

274. The demarcation was most indifferent. The attention of the Circle officers was called to the very unsatisfactory state of the demarcation, but with little or no result.

275. There were altogether 235 boundary disputes, of which only 75 have been settled up to date. In order to complete the records of the villages in which the balance of 160 undecided boundary disputes still exist, the disputed portions have been mapped in blue and the *khanapuri* written up according to possession, all field numbers under dispute being entered in the dispute lists.

276. A peculiar feature in this work is the mapping of *kharras* (diminutive irrigation channels), which are all shown at the request of the Collector. There was no difficulty about the survey of these *kharras* as they run along field boundaries, but it was impossible to show them to scale, so they have been shown by a dotted line running parallel and close to the field boundary. These *kharras* are generally of a temporary character, and are simply dug when necessary. They would not in the ordinary course be shown, but are apparently required in Gaya on account of the importance attached to irrigation rights.

277. The attitude of the inhabitants was generally favourable to the survey. In a few cases the *amin* was obstructed, but enquiries proved that ignorance of the survey procedure was invariably the cause. A great number of the traverse stations that were not on the actual boundary had however been moved, undoubtedly under the impression that possession would be affected. Several attempts were made to ascertain who were the guilty parties, but without avail.

278. Fever was very prevalent during November and December, and in April cholera broke out in the district, but only one death occurred in the establishment from this cause. Influenza, eczema and ulcers were very prevalent and incapacitated some men for work at various times.

279. At the commencement of the season the daily average out-turns per *amin* were as follows:—

Foreign *amins*, 13 acres of survey, or 28 numbers of *khanapuri*.
Local do. 7 ditto 27 ditto.

By the close of the season the following averages had been reached:—

Foreign *amins*, 17 acres of survey, or 30 numbers of *khanapuri*.
Local do. 12 ditto 34 ditto.

280. The difficulties met with in the survey of the Tikari Ward's estate have been numerous and exceptionally heavy.

281. The particulars of the cadastral survey and record-writing in the *sir* and *thika* villages completed during the season are shown in the following statement:—

District.	Cadastral Survey, 16 inches = 1 mile.			Record-Writing. (Khanapuri.)		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Gaya	543	434,620	408	458	400,351	332

282. The average size of the field, calculated on the area of which the records were written, excluding jungle and hills, is 0·65 of an acre.

283. The detail survey is mapped on 684 sheets and was checked by 1,291 linear miles of test lines run by the European officers and by 1,253 linear miles run by inspectors, the total being 2,544 linear miles, which gives an incidence of 6·23 linear miles of check work to each square mile of survey. This is a very heavy proportion of testing, but as the agency employed was not up to the usual standard, it was thought advisable to increase the check surveys. The work has all proved well.

The number of *khasra* entries tested by the European officers is 7,751 and by native inspectors 74,528, or a total of 82,279, which gives an average of 20 per cent. on the whole number of entries. No figures are forthcoming for the checking done by Assistant Settlement Officers.

284. Of the 543 villages surveyed in this work, the sites of 299 have either been surveyed on the 32-inch scale, or enlarged to that scale on the margin. In four cases the village sites were enlarged to the 64-inch scale as the plots were very minute. The Collector thinks it important that each man's dwelling site should be entered in the village papers. He says the householder highly values the site, and that there are more disputes among the *rayats* on the estate about the sites than as regards the cultivation.

285. Only 4 square miles of hills have so far been surveyed on the 16-inch scale; and as it was proving costly, no more will be done. The word "hills" will, in future, appear in spaces where such occur, which will answer all requirements.

286. The total expenditure on the 16-inch survey has been ₹53,911, of which ₹33,688 are debitable to cadastral survey, including completion of maps, areas and traces, and the balance ₹20,223 to *khanapuri* and completion of records, etc., the resulting cost-rates being, cadastral survey, etc., ₹85·7 per square mile, and *khanapuri*, etc., ₹60·9 per square mile.

The cooly payments on this work amounted to ₹5,951-4-6. This sum has been included under the head of cadastral survey, but in itself, without any shares of general section, it gives an incidence of ₹14·9 per square mile.

Revision of the 32-inch maps of the villages included in the Irrigation survey of 1875-76.

287. This work consisted in bringing up to date the maps of such villages of the Tikari Ward's estate as had been surveyed in 1875-76 on the 32-inch scale by the Sone Canal Irrigation Survey and in revising the *khanapuri* of the same.

In the old maps, the "field" was the unit of survey, each field being numbered in English, but in addition all the sub-divisions (*kittas*) in a field were mapped, each being given a letter of the alphabet. The village sites also were only surveyed in blocks. The revision survey therefore consisted of (1) altering on the map the boundaries of the "fields," where the limits of the occupancy of the cultivator had altered since 1875-76, to accord with existing facts; (2) to survey entirely anew all tracts of land shown on the old maps as waste, but which had since been brought under cultivation; (3) to cut out all *kiaris* (boundaries of *kittas*) on the old map which did not exist at the time of the present survey, and to survey and enter all such *kiaris* as had been since constructed and were in existence at the time of present survey; (4) to survey all village sites on the 32-inch scale entirely afresh on the margin of the plan, showing each house and separating the houses from their homestead lands; also (5) to survey all distributary canals, roads and all other changes which had occurred since 1875-76.

288. The following statement gives the out-turn accomplished in the revision work:—

Pargana.	Detail Survey, 32-inch scale.			Record-Writing. (Khanapuri.)		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Arwal	29	101,877	43·6	5	8,590	8·1
Siris	18		19·3	18	9,547	19·2
Totals .	47	101,877	62·9	23	18,137	27·3

The old numbers of fields have been crossed out in red, and the new numbering, which is in Kaithi, has been entered in red.

All *kittas* have been shown, but this is to be discontinued for the future; they are not necessary for settlement purposes, and their survey increases the cost considerably.

289. The correction of the old area statements has proved so laborious, owing to the very many changes not only in field boundaries, but in large tracts of waste which have been brought under cultivation owing to the building of dams and irrigation distributaries, that it was found quite impossible to use the field area statements of the former survey.

290. The average size of the field calculated on the area of which the records were written is 0·96 of an acre. The average size of the *kitta* is only 0·29 of an acre.

291. The survey is mapped on 183 sheets and was checked by the inspectors and other officers who measured to the corners of fields when inspecting the *khanapuri*. An attempt was made to run test lines as elsewhere, but this had to be abandoned, as the old traverse stations could not be found in the majority of cases.

Of the total number of 18,137 plots of which the records were written, the entries of 398 were checked by European officers and 2,529 by inspectors, or altogether 2,927, being 16 per cent. of the total number of entries.

292. The expenditure on this work has been, on surveying ₹2,955, and on records ₹822, or a total of ₹3,777. The resulting cost-rates per square mile are, for detail survey and completion of cadastral maps ₹46·9, and for *khanapuri* ₹30·1. No expenditure in the revision area has been incurred as yet on extraction of areas, traces or completion of records. The expenditure on coolies in this work has been ₹443, which amount, although included in the total for detail survey, gives by itself a cost-rate per square mile of ₹7.

Skeleton survey of boundaries of "Mukarrari" villages.

293. This work consisted simply of the survey on the 16-inch scale of the boundaries of villages given out by the estate on *mukarrari* lease; the object being to arrive at the correct areas of each village.

294. The out-turn accomplished consists of 224 villages having an area of 147·2 square miles. It is believed that to complete all the *mukarrari* villages of the estate in Gaya, there still remain 22 villages covering 7 square miles, provided that the share of the estate in each is not less than 8 annas. The Manager has asked that 20 villages covering an area of 17 square miles, which have already been surveyed in outline, may be surveyed in detail, including the record of rights, because he disputes the claims of the *mukarraridars* in those villages.

295. The expenditure on this work for survey and completion of maps has been ₹1,589, which gives a cost-rate of ₹10·1 per square mile.

296. The establishments of this section were inspected by the Director, Bengal Surveys, on 24th and 25th October 1893 and the field work on 12th and 15th January, and on 3rd February 1894; on the last occasion in company with Mr. D. J. Macpherson, the Collector of the district, who takes a deep interest in the work. The section was inspected in recess quarters at Dinapore on 16th July 1894.

Survey of the Chakla Roshnabad and Gangamandal Estates,

Districts Tippera and Noakhali.

297. This detachment, of the strength noted in the margin, resumed operations in the Roshnabad estate on the 1st December 1893, the programme for the season being as follows:—

Personnel.

Mr. J. McHatton, Extra Assistant Superintendent, 5th grade.
2 head-inspectors.
17 inspectors,
6 imported *amins.*
200 local *amins.*

(*a*) Cadastral survey of 265 square miles.
(*b*) Record-writing of 352 square miles.

The survey of three villages of the Gangamandal estate, aggregating in area 1·16 square miles, was also included in the season's programme at the request of the Director of Land Records.

298. The traverse survey (of the Chakla Roshnabad estate) was all completed during the previous season, and the cadastral survey of 742 villages, having an area of 289 square miles, was likewise then completed, but of this area the records of only 202 square miles had been written.

The operations have been prolonged over two seasons at the special request of the Maharaja of Hill Tippera, who required time for needful vigilance against fraudulent claims.

299. During the season under report the following has been the out-turn of survey and record-writing:—

District.	Estate.	Cadastral Survey, 16 inches=1 mile.		Record-Writing. (Khanapuri.)	
		Number of villages.	Area in square miles.	Number of villages.	Area in square miles.
	Chakla Roshnabad.				
Tippera . . .	Central Division . .	543	133·1	877	220·1
Noakhali . . .	Southern Division . .	209	127·9	209	127·9
	Totals .	752	261·0	1,086	348·0

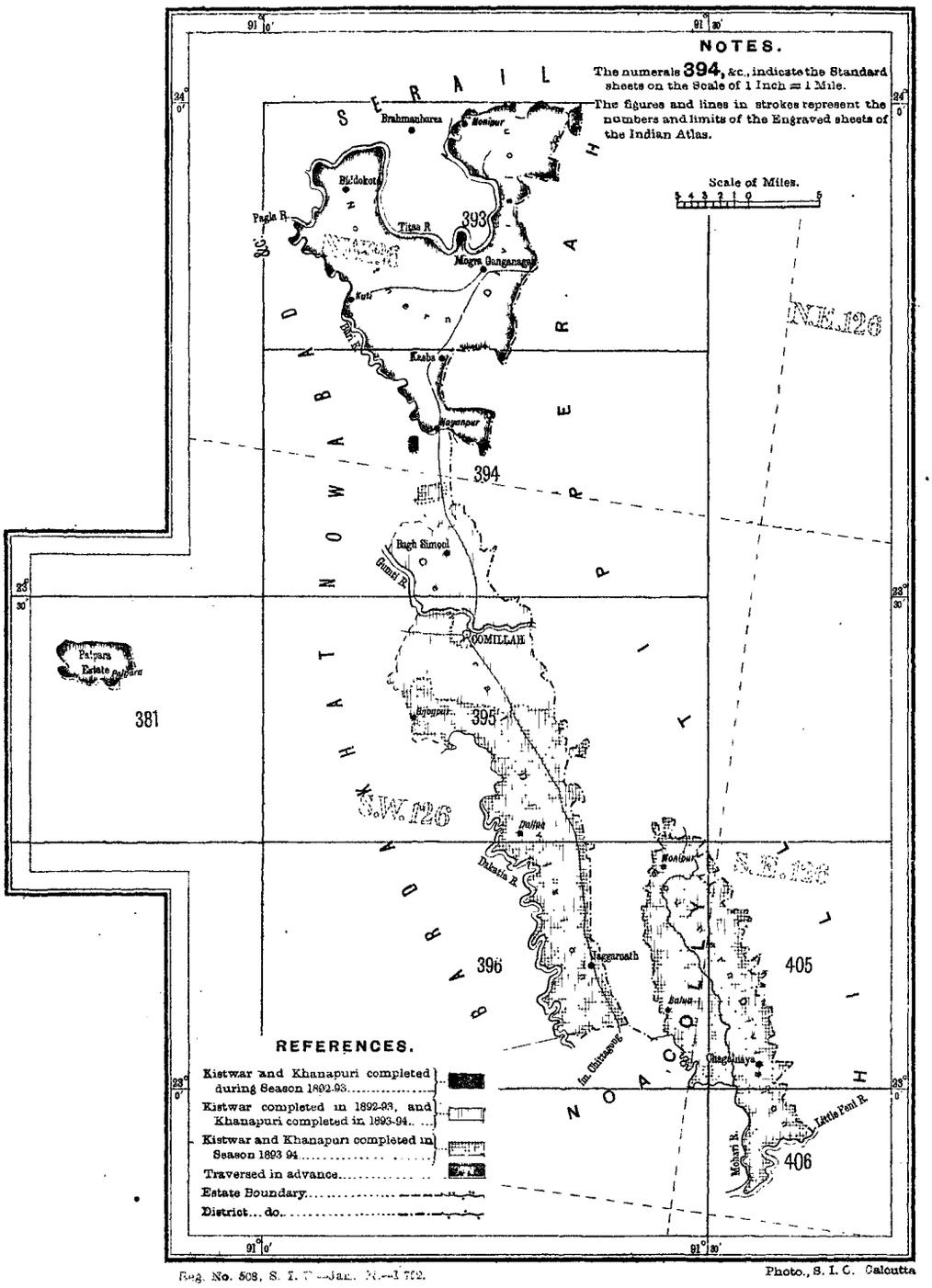
300. The number of fields in the Central Division was 375,542 and in the Southern 269,007, or a total of 644,549 fields. The average size of the village is 166 acres in the Central Division and 390 acres in the Northern, and the average size of the field calculated on the whole area is 0·34 acres. The season's out-turn of cadastral survey is mapped on 1,036 sheets. The daily average out-turn of the men has been 15 acres of surveying.

301. The detail survey has been checked by 1,000 linear miles of test lines which gives an average of nearly four linear miles of check work per each

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF CHAKLA ROSHNABAD, DISTRICT TIPPERA.

1893-94. No. 2 PARTY.



Reg. No. 508, S. I. T.—Jan. N.—1792. Photo., S. I. C. Calcutta

No. 306-S. 95.

square mile of survey. Of this, 1·2 linear miles per square mile were done by European officers, or are independent checks. At his inspection in April 1894, the Director, Bengal Surveys, looked through the results of the check surveys and satisfied himself that the work was of good quality.

302. The record-writing has been done under the direction of three different Settlement Officers during this season. The Survey Officer has also checked the *khanapuri*. The number of *khasra* entries which have been checked by the officers of the Settlement and Survey Departments is 59,101. No less than 127,500 others have been checked by the native inspectors, which makes the total 186,601 or 29 per cent. of the total entries recorded.

303. Only 21 boundary disputes were reported. Of these, five refer to the political boundary between British and Hill Tippera, and 16 are so-called boundary disputes between villagers. The former have all been disposed of and of the latter, nine have been disposed of and seven are still pending.

304. The obsolete revenue survey *thak*-map boundaries, which are unsuitable for adoption as the limits of the map unit, have, however, been indicated in approximate position on the maps of the existing *mauzas*, with the result that no less than 62 per cent. of them show a divergence from the *mauza* boundaries of the present survey, which follow the separate rent-paying tracts registered as distinct *mauzas* in the collectorate registers.

305. The expenditure on the above operations has been R41,187 for survey and R36,077 for record-writing, which gives cost-rates per square mile of R151 for survey and R102 for records.

306. The survey and record-writing of the whole area comprising the Roshnabad estate has now been completed. It is found to comprise an area of 357,854 acres or 559·15 square miles.

307. The survey of the Gangamandal estate was also undertaken. It consists of three villages, two of which are grouped together and are situated about eleven miles to the north of Comilla, the distance from the northern-most extremity of the Roshnabad estate being about five miles; the third lies about nine miles to the north-east of the other two and about three miles to the west of the village of Moenpur of the northern division of the Roshnabad estate.

308. All three villages, Rampur, Pachara, and Ranigach, were traversed; they cover an area of 741 acres, or 1·16 square miles. The angular observations numbered 38, and the boundary survey consisted of 8 linear miles. In addition to this 4 linear miles of traverse lines were run and 16 angles observed on the polygons framed to connect these detached surveys with the main traverses Nos. 2 and 3 of the Roshnabad estate. All the traverse stations were marked with glazed pottery cylinders.

309. The cadastral survey and record-writing was completed in Rampur and Pachara, but in Ranigach it was suspended by an order of the Collector (letter No. 2799G., dated 28th March 1894) to Mr. MacHatton's address. This order was cancelled in letter No. 1372G., dated 15th August 1894, but as the country was under water, the work could not be again undertaken. The area of the two villages cadastrally surveyed is 572 acres, in which there are 2,071 fields. These are mapped on three sheets.

310. The cost of cadastral survey and records has been R107 and R80 respectively. The resulting rates are R120·2 and R90·7 per square mile.

311. The survey of the town of Comilla was commenced in December 1893. The area comprised within municipal limits is 2,384 acres; of this, the bazar and native quarter cover 352 acres, the civil station occupies 1,140 acres, and there are 892 acres of suburbs. The scale of survey has varied in all these tracts to suit the details required to be mapped. The native quarter was done on the 64-inch scale, the civil station on the 32-inch, and the suburbs on the 16-inch scale. The survey is mapped on 27 sheets.

The number of plots is 8,682. The record of rights was prepared under the immediate supervision of the Settlement Officer.

312. The weather during the season was remarkably favourable for field work, there being no rain from December 1893 to April 1894. Cholera prevailed during December, January, February, and March, but there were only two deaths during the field season. The coolies coming from Hazaribagh, however, contracted cholera on the road, and 15 deaths occurred before work began.

313. The detachment that has been employed on these operations will be transferred to the Darjeeling district to undertake the survey of the Tarai *jotes*.

314. The Director, Bengal Surveys, inspected Mr. MacHatton's field and office work early in April, and was met by the Collector and Mr. MacMinn, the manager of the estate, and in the inspection notes for that month he wrote: "Mr. MacHatton has satisfied me that he has made successful efforts to carry out the survey in the best possible manner."

SURVEY OF THE PALAMAU GOVERNMENT ESTATE, CHOTA NAGPUR.

315. The whole area of this estate, which contains 386 villages, was said to be about 273,635 acres, of which 70,400 acres were supposed to be cultivated, and thus requiring survey; but this estimate has proved to be much below the actual, for during the year under report 83,622 acres, of which 64,640 are under cultivation, have been surveyed, and, judging by the area traversed in advance, there would appear to be as much more for cadastral survey. Mr. Berkeley estimates it at 154 square miles more, contained in 176 *mauzas*.

Personnel.

Mr. L. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
„ P. K. Vaughan, „ „ 3rd „
1 head inspector.
7 inspectors.
68 local *amins*.

316. The out-turn of traverse survey during the previous season comprised 56 villages with an area of 37·7 square miles in *tappas* Pundogkote, Tallia, and Goawal. The traverse operations during this season have been continued in *tappas* Amhar, Baresand, Bari, Barkol, Chhechari, Durjag, Duthu, Goawal, Imli, Khamhi, Kote, Mankeri, Pundag, Seema, Sirhe, Tallia, Japla and Tappa, and cover an area of 280 square miles, comprising 342 villages.

The number of stations in the area traversed is 10,475: at all of these stations specially marked stones were embedded. The linear miles of boundary traverses are 940, and of sub-traverses 844. Azimuth observations were taken at 120 stations and ten stations of the Calcutta Longitudinal and of the Harilaong Meridional Series, G.T. Survey were connected with.

317. The field season lasted from 1st October 1893 till 21st June 1894.

318. In making a traverse survey of scattered cultivation, it is impossible to always avoid the inclusion of waste and jungle, when they are much mixed with the cultivation. The areas of these blocks amount to 23·65 square miles.

319. The cost of the season's traverse survey was R6,748, giving a rate of R24·1 per square mile.

320. The traversing of the *khalsa* (paying rent to Government) villages is now completed, but there remains on the estate 174 more villages, with an area of 181 square miles in jungle and hilly tracts, the survey of which has not yet been decided on.

321. *The Cadastral Survey.*—The district of Palamau is situated on the spurs of the Sirguja, Lohardaga and Hazaribagh plateaux, hence the country is hilly and broken by ravines, and the difficulties of carrying out a cadastral survey are greater than ordinary. The most level and best cultivated tract in the season's operations is in *tappas* Kote, Imli and the middle portion of *tappa* Pundag in the valley of the Amanat, but even this tract is in parts cut up by water-courses. *Tappas* Sirhe, Goawal and Tallia in the valley of the Koel, in which operations were also in progress, are not so well cultivated but are more broken and covered with brush wood. *Tappa* Bari, the southernmost of the *tappas* in which cadastral work proceeded, lying in the valley of the Koel and Auranga, is intersected with a number of low hills covered with *khair* and bamboo jungle. Although it is very wooded, undulating and raviny, cultivation has greatly increased, and in it is situated *mauza* Bari, one of the finest and largest of the *khalsa* villages.

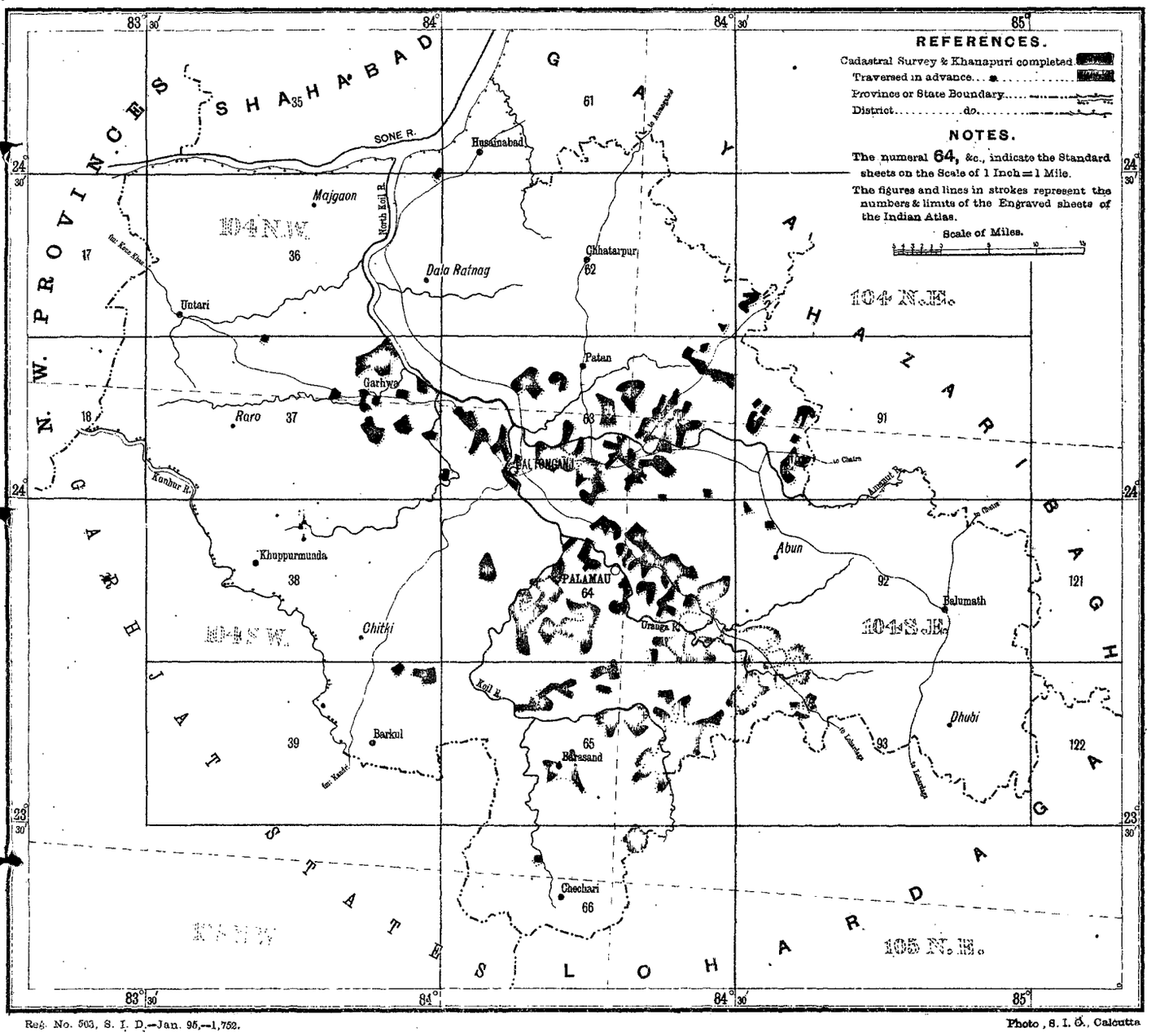
322. Cadastral operations were commenced on 1st November 1893. The field surveyors were locally trained. Out of the 78 men who were under instruction last year, only 53 took the field, the rest having gone to their homes on various pleas; in December 1893 and January 1894 the number was increased to 66, and reached the maximum of 74 men in March and April 1894.

Mr. Berkeley characterises the Kols as an indolent class of men, to whose laziness a great deal of the slow progress of the work is due. A system of

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT PALAMAU.

1893-94. No. 2 PARTY.



Reg. No. 503, S. I. D.—Jan. 95.—1,752.

Photo, S. I. O., Calcutta

No. 309-S. 95.

rewards for large out-turns was sanctioned, but these had no effect as inducements to exertion.

323. The following statement gives the details of the out-turn of cadastral survey and record-writing:—

District.	Cadastral Survey, 16 inches=1 mile, with Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.
Palamau	210	95,000	130·7

324. Of the area surveyed, 23·6 square miles consist of waste and jungle. In 14 of the surveyed villages in Tallia, Goawal, Sirhe and Pundag *tappas*, Government is only part proprietor, but in these instances the cultivation of the *khalsa* portion only has been surveyed and recorded in accordance with possession. In some cases it has been difficult to locate and even to ascertain the extent of the *khalsa* lands, for the old maps are far from accurate; but comparisons of the two surveys have been made as far as possible, and the differences noted for the information and orders of the Settlement Officer.

325. The area of the unsurveyed *jagirdari* (revenue-free) portions of these 14 *mauzas* is 5·7 square miles. The net area of cultivation in the 210 *mauzas* cadastrally surveyed is 101·3 square miles, and the average size of the field is 0·69 of an acre.

326. The check lines which were run to test the accuracy of the survey amount to an average of 3·37 linear miles in every square mile of survey. The number of entries in the *khasras* which were tested averaged 33 per cent. of the whole.

327. The number of boundary disputes which are reported amount to 97. Mr. Berkeley disposed of ten of these under the orders of the Deputy Commissioner, who delegated powers to him under certain sections of the Survey Act.

328. When operations were first commenced, the amount of fever and of skin diseases was abnormal, and cholera raged during the latter part of the season, which retarded the work. The field season closed on July 15th, but the *khanapuri* in three villages, which had to be postponed on account of cholera therein, was not completed till September.

329. The expenditure in the cadastral section has been ₹12,117 for survey and ₹8,204 for records; the cost-rates are ₹94·1 and ₹73·7 per square mile respectively, or together 4 annas 2 pie per acre. This is a low rate for a small piece of work on which the incidence of the supervision falls heavily of necessity. Had it been known from the first that the area for cadastral survey was as large as it has since proved to be, more men would have been trained and the work done more quickly. When it became apparent that the area had evidently been under-estimated, efforts were made to obtain *amins* from Bihar, but none could be induced to go to Palamau, which to them is a *terra incognita*.

330. Mr. L. F. Berkeley deserves praise for his conduct of this survey; he was under the orders of Mr. Bright, the Deputy Commissioner, whose keen interest in the work has done much towards getting it through so far in face of many difficulties.

331. The Director, Bengal Surveys, accompanied by Mr. Bright, inspected the survey party in the field on the 25th, 26th and 27th January 1894.

Survey of the Jaipur Government Estates, District Bogra.

332. During the previous season the traverse survey of these estates had been nearly completed, the out-turn being 60·41 square miles, inclusive of intermixed lands, which form no part of the Government estates.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 6th grade.
„ A. B. Smart, Sub-Assistant Superintendent, 2nd grade.
1 head inspector.
1 inspector.
16 Hindustani *amins*.
12 *muharirs*.

333. During the current season it has been found necessary to survey lands in 17 villages with an area of 3·5 square miles. One sub-surveyor, starting work on 20th December, was found insufficient to complete the survey, and another had to be sent to his aid early in March, for the villages to be newly traversed were far apart and their whereabouts was not precisely known, and the revisions of angular and chain measurements proved more numerous than was anticipated. The out-turn of new work contains 332 angular observations and 39·56 linear miles of chaining. Two hundred and fifty permanent marks were embedded and the manager has promised to see that mounds of earth are piled over the theodolite marks for their better protection.

334. The cadastral survey of these estates was begun during the previous year, when the out-turn comprised 22 villages having an area of 13·15 square miles. It was continued during the present season and eventually brought to a conclusion. There was no continuous European supervision as the Head Inspector was considered capable of conducting the operations in the small area to be dealt with, but Mr. A. B. Smart, Sub-Assistant Superintendent, inspected and checked the work about once a month. The field surveyors consisted of Hindustani *amins*, the *muharrirs* writing the records being Bengalis; a few of the latter were eventually employed on measurement also. The Hindustanis were preferred in the first instance for the sake of economy, as they work so much faster than the Bengalis. The establishment took the field about 20th December 1893.

335. The following has been the out-turn of the season :—

District.	Cadastral Survey, 16 inches=1 mile.			Record-writing (Khanapuri.)		
	Number of fields.	Number of villages.	Area in square miles.	Number of fields.	Number of villages.	Area in square miles.
Bogra . .	41,347	133	42	55,347	155	55

336. The whole of the vernacular records have been completed and despatched to the Collector of Bogra.

337. The average size of the field is 0·65 of an acre. The check surveys of all kinds are 175 linear miles, which gives an average of over 4 linear miles of test per each square mile of survey.

338. The total cost of the cadastral operations, including the record-writing, during the season has been R6,366; the rate per square mile is R138·2. This does not include the cost of the traverse survey.

339. The Jaipur Government estates, of which the survey has now been completed, are 8 in number, and contain lands in 155 villages with an area of 55 square miles. The estates are not in one ring fence, but the out-lying portions are not more than two or three miles from the main block.

340. A survey of these estates was made by the Settlement Department in 1878, and for comparison purposes the boundaries have been transferred from these maps to the maps of the present survey. The results are not altogether satisfactory, for they point to either considerable changes or possibly inaccuracies in the former survey.

341. The Director, Bengal Surveys, inspected the work in the field in the end of April 1894.

Survey of the Rajapur Drainage Area, District Hooghly.

342. The cadastral survey of the lands benefited by this drainage scheme was continued during the year under report and brought to a conclusion by the establishment marginally noted.

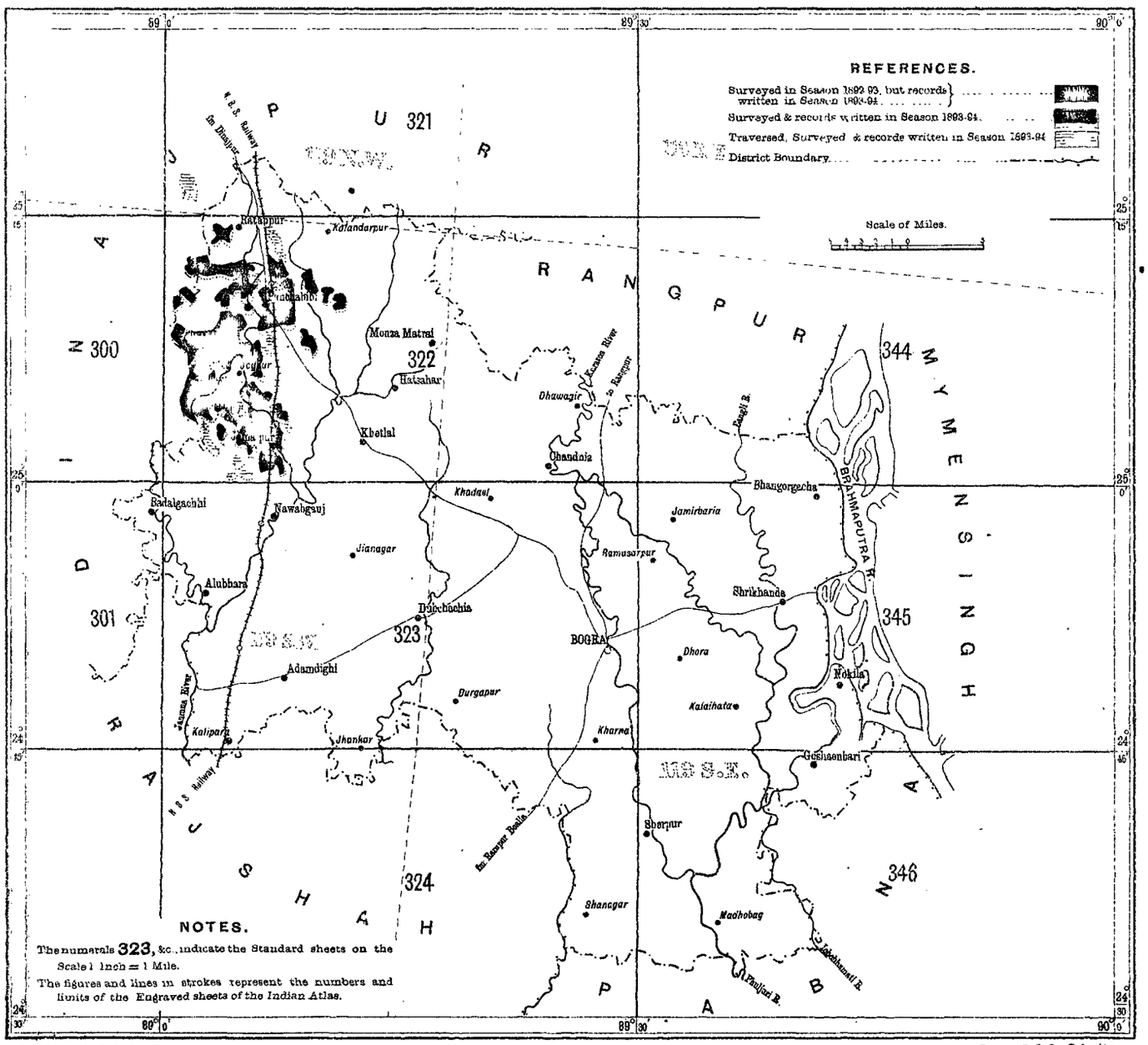
Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 6th grade.
„ P. A. Peters, Extra Assistant Superintendent, 6th grade.
„ A. B. Smart, Sub-Assistant Superintendent, 2nd grade.
1 head inspector.
1 inspector.
14 Hindustani *amins*.

The object of the survey is to ascertain the extent,

BENGAL SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT BOGRA.** No. 2 PARTY.



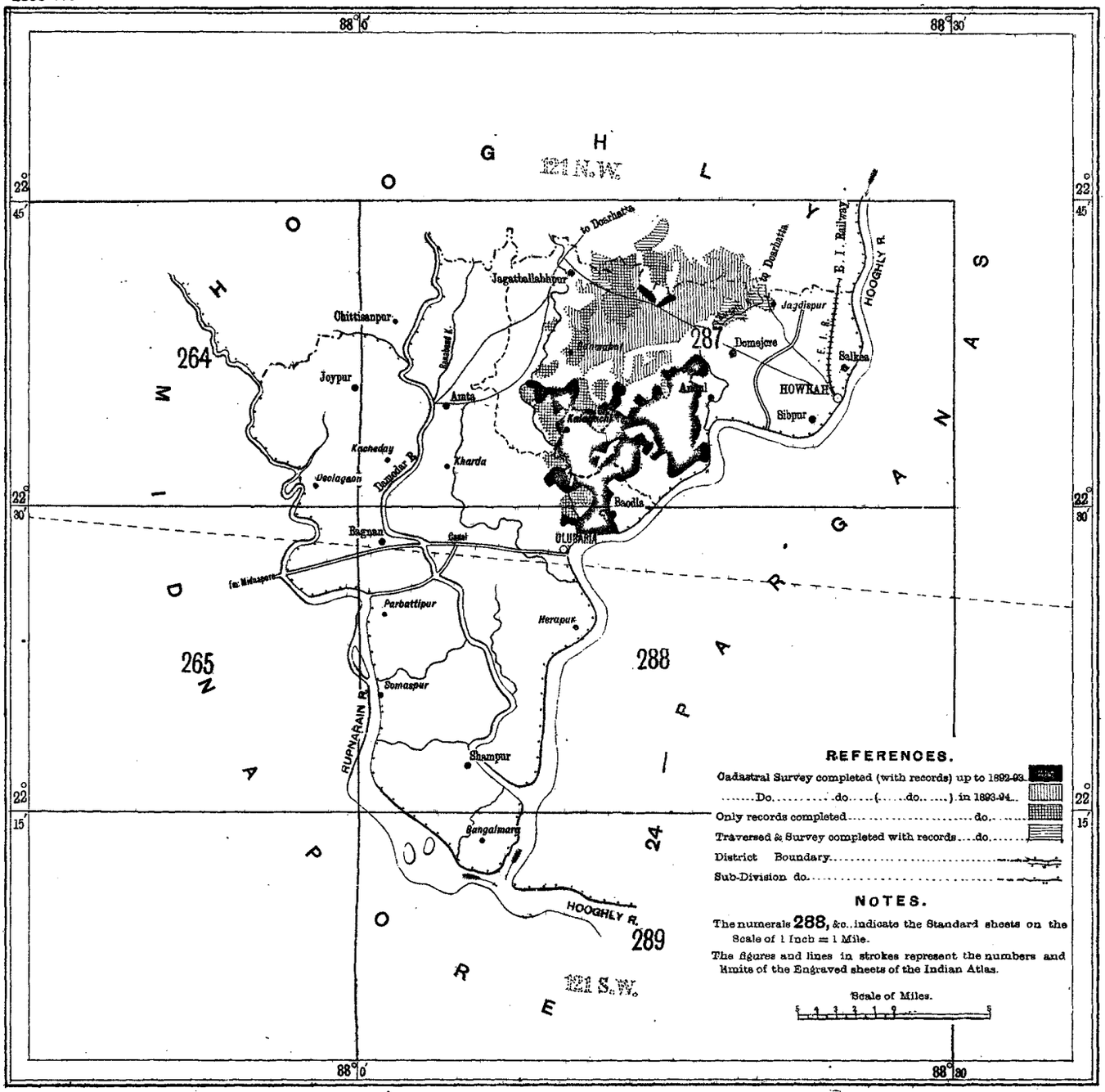
Reg. No. 509, S. I. D.—Jan. 95,—1,752. Photo., S. I. O. Calcutta.

No. 304-S. 95.

BENGAL SURVEY.

RAJAPUR DRAINAGE SURVEY.

1893-94. INDEX TO THE CADASTRAL SURVEY IN DISTRICT HOWRAH. No. 2 PARTY.



Reg. No. 503, S. I. D.—Jan. 95,—1,752.

Photo., S. I. O., Calcutta.

No. 301-S. 95.

nature and proprietors of the lands benefited by the drainage scheme, with a view to assessment in accordance with the enhanced value of these lands.

343. As in the case of the Jaipur Government estates in Bogra there was no continuous European supervision, the immediate conduct of the operations being entrusted to a Head Inspector, Munshi Girdhari Lall, but the European assistants paid periodical visits to test the work.

344. The work remained to be undertaken during the year was estimated at—

Traverse survey of 13 villages . . . . . 9 square miles.
Cadastral survey of 64 „ . . . . . 41 ditto.
Khanapuri of 82 villages containing 50,000 fields.

But, as will be seen from the returns later on, these figures were under-estimated owing to the difficulty of foretelling the actual areas benefited by the scheme.

345. Traverse operations were begun early in January 1894, but much delay was caused because notices had not been served on the *rayats* to attend and point out their boundaries.

During the previous season permanent marks were not placed at all the theodolite stations, the Drainage Deputy Collector objecting on the score of cost. In places, the new traverse survey had to emanate from and close on theodolite stations not permanently marked, and much time was lost in hunting up stations which could be utilised. Thus the small area of traverse was not finished till the 20th April 1894.

346. The out-turn of the season's traverse work has been—

District.	Number of villages.	Number of traverse stations.	Linear miles of chaining.	Area in square miles.
Hooghly	27	436	66·5	9·9

347. *The Cadastral Survey.*—The out-turn of the previous season had been the cadastral survey of 92 villages, having an area of 43 square miles and the record-writing of 51 villages with an area of 29 square miles. During the season under report the whole of the area remaining for survey was completed. This was situated generally to the north and east of the tract previously dealt with, and is about 12 to 16 miles west of Howrah. The work began early in January 1894, for the country being very low-lying was not fit for survey earlier; in fact much of it was under water at the end of February. The writing of the records was done by Bengalis under the immediate supervision of the Drainage Deputy Collector: this arrangement was arrived at as being the most economical and convenient.

348. The out-turn of survey and *khanapuri* for the season is as follows:—

District.	Cadastral Survey, 16 inches=1 mile.				Record-writing. (Khanapuri).		
	Number of villages.	Number of fields.	Area in square miles.	Average size of fields in acres.	Number of villages.	Number of fields.	Area in square miles.
Hooghly . . .	85	57,583	36·5	0·40	106	46,972	51·0

349. The unit of measurement was necessarily the *kiari* or cultivating division and not the "field," as cultivators will not attend at purely measurement work which they do not understand, and which does not appeal to their immediate interests. It is only when the record is being prepared and *parchas* (slips) distributed that they take any interest in the operations and point out the limits of their holdings.

350. The average length of the test of the detail survey has been 3·6 linear miles to each square mile of survey. It is not known what tests were applied to the record-writing as the Drainage Deputy Collector was wholly responsible for the conduct of that operation.

351. The cost-rates per square mile of the season's operations have been, of survey ₹133 and of record-writing ₹32.

352. The Deputy Collector did everything in his power to bring the work to a successful conclusion and has reported most favourably of the Head Inspector, Girdhari Lal, with whom he worked most cordially.

353. The Director, Bengal Surveys, inspected the office of this detachment on 30th and 31st March and the field work on 26th April 1894.

SURVEY OF THE PATASPUR GOVERNMENT ESTATES, DISTRICT MIDNAPUR.

354. The survey of this group of estates, which was notified under section 101 (2) (*d*) of the Tenancy Act of 1885, in the *Calcutta Gazette* of 25th October 1892, was completed during the previous season; but the record-writing was abandoned after the *khasras* of 40 villages had been written, owing to the setting in of the rains, and these were made over to the Settlement Officer for completion under an arrangement with the Director of the Department of Land Records. During the season under report the completion of records and the compilation of statistics have been undertaken.

355. The original 16-inch sheets, except of 17 villages of which the records had been already written, were made over to the Settlement Officer for the purposes of *khanapuri* on the 13th December 1893 and were received back on the following dates :—

	Villages.
14th February 1894	20
26th March 1894	18
25th April 1894	16
22nd June 1894	2
TOTAL	56

356. Since then areas have been extracted of all of the above, but *milan khasras* were not prepared of 59 villages, as the Settlement Officer had need of the records for attestation and would not give time, nor could crop statements be prepared for any of the villages for the same reason. The records of 96 villages have been despatched to the Settlement Officer, of which only 16 villages were sent after May 1894.

357. The total area of the estates is found to be 54·6 square miles.

SURVEY OF THE CHAURASI ESTATES, DISTRICT 24-PARGANAS.

358. The two estates of Chaurasi, said to have an aggregate area of 20,464 acres, are situated in the sub-divisions of Barasat and Basirhat, of the district 24-Parganas. The one situated in the former sub-division contains the bulk of the area. The survey has been undertaken at the request of the proprietors. The notification under the Survey Act did not appear in the *Calcutta Gazette* till the 27th June 1894, which may account for the opposition of the *zamindárs* at the start, which is mentioned hereafter.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 6th grade.

Mr. P. A. Peters, Extra Assistant Superintendent, 6th grade.

6 sub-surveyors and computers.

359. It was desirable to get some area traversed in advance of the cadastral survey, which obviously could not be undertaken so late in the season; consequently the traverse survey was begun in the Barasat sub-division. The lands traversed are in three blocks between the Dattapukur and Habra stations of the Bengal Central Railway. One block of 10 villages is situated immediately north of the former station; the other two blocks are south and east of Habra station.

360. Work was commenced on the 13th May by dividing the tracts to be surveyed into four small circuits and field-work was closed on the 10th July 1894, the out-turn of the traverse survey, comprising 55 villages, with an area of 32 square miles, in which were 191 linear miles of chaining. The total

number of stations observed at was 1,078 of which 200 are at the tri-junction of villages, 650 on the boundaries, and 228 in the interior. All theodolite stations were marked with pottery cylinders obtained from Messrs. Burn & Co., except 126 stations which were marked with pottery jars containing some charcoal. Azimuth observations were taken at 8 stations.

361. When the survey first commenced the proprietors of adjoining estates removed the permanent marks, and in one instance warned the surveyor that any further attempt to mark stations, or to carry on the survey, would be resisted; in another instance the surveyor was attacked. But after the Sub-divisional Officer had been to the spot and explained the objects of the survey there was no further obstruction.

362. The total cost up to 30th September 1894 has been R1,296, giving a rate of R40·5 per square mile for the traverse survey.

SURVEY OF THE BURDWAN ESTATES, DISTRICTS BURDWAN AND HOOGHLY.

363. The cadastral survey of certain *mahals* of the Burdwan Raj Ward's estate were undertaken under Government orders. These had been omitted from the previous survey as the Burdwan estate authorities could not point them out: they were again notified for survey on 14th Feburary 1894. The work was supervised in the field by a Head Inspector, Mr. A. B. Smart, visiting the *amins* occasionally, as was done in the Jaipur Government estate survey and at Rajapur.

Personnel.

Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade.
1 head inspector.
1 inspector.
2 sub-surveyors.
8 *amins*.

364. In February the traverse survey was undertaken by sending two traverse surveyors to the Manager's office at Burdwan for guides to point out the villages. The *mahals* to be surveyed were found to be much scattered: no two of them being contiguous. Two villages were close to Kalna, north-east of Burdwan district, one close to the loop line, East Indian Railway, in the same district, and another some miles east of Burdwan town. One village lay a few miles west of Tarkessar shrine in the Hooghly district, and the remainder in the Jahanabad sub-division bordering on district Bankura.

365. The out turn of traverse work is as follows:—

District.	Number of villages.	Number of traverse stations.	Linear miles of chaining.	Area in square miles.
Burdwan	8	213	25·0	6·0
Hooghly	14	261	52·9	5 9
Totals .	22	474	77·9	11·9

366. *The Cadastral Survey.*—On the 15th March 1894 one Bengali inspector with eight Bengali *amins* left Calcutta for Burdwan to commence the cadastral survey. They were sent to the Manager in the first instance, so that arrangements could be made for attendance of representatives of the Raj. On the 24th March the inspector reported having started work.

367. During April four of the Bengali *amins* absconded leaving only four *amins* at work. The season being so far advanced, no *amins* were immediately available, and it was only on the 1st of June that five Hindustani *amins* were sent from the Rajapur drainage survey, which was nearing completion. A Hindustani head inspector also relieved the Bengali inspector.

368. In one large village—Kaliyanpur—the Raj authorities were unable to point out the estate lands, as they were so mixed up with the lands of other proprietors. The village having only recently been resumed from *patni* lease was the reason adduced for this want of knowledge; and the *rayats* pleaded that although they knew the amount of rents they paid to each of the different proprietors, they could not specify the fields of each. The *thakbust* map was procured, but it was found that without a measurement of the whole of the fields

in the village it would be difficult to locate the different interests shown on the *thakbust* map.

369. The Settlement Officer of the *khas mahals* drew up rules for record-writing, and copies were supplied to the *amins* for guidance. For reasons which could not be ascertained a number of *rayats* on this estate refused to take their *parcha* slips. The Settlement Officer inspected *khanapuri* during July, and wrote as follows:—"The survey inspector having represented to me that the *rayats* refuse to take *parcha* slips, I tried to make it clear to them that the course they were following was likely to prove prejudicial to their own interests. It seems hopeless to bring the illiterate section of the *rayats* to a full appreciation of their rights and responsibilities."

370. Although the work was continued till the end of July, after which the establishment could not be kept in the field, *khanapuri* was unfinished in three villages. This is due principally to the work having been begun so late in the season, to the absconding of the *amins* and to one village becoming inundated.

371. Mr. A. B. Smart left Calcutta for inspection on the 26th April and returned on the 16th May, having seen the whole of the *amins* except two at work.

372. The detail survey was checked by 23 lineal miles of test survey which gives an average of 2 linear miles for each square mile of survey. Some oft he work still requires to be tested independently, which will be effected in the ensuing season.

373. The out-turn of detail survey and record-writing has been as follows:—

District.	Cadastral survey, 16 inches = 1 mile.				Record-writing (Khanapuri).		
	Number of villages.	Number of *kiaris*.	Area in square miles.	Average size of field in acres.	Number of villages.	Number of fields.	Area in square miles.
Burdwan . . .	8	14,549	5·4	0·24	4	4,907	3·2
Hooghly . . .	18	8,592	4·0	0·30	17	5,902	2 6
Totals .	26	23,141	9·4	...	21	10,809	5·8

374. The extraction of areas was started before the close of the survey year, but the completion of the papers has not yet been undertaken. This will be finished early next season, so that the Settlement Officer can start his work during the cold weather.

375. The expenditure has been ₹1,474 and ₹457 on the survey and records respectively; the corresponding cost-rates per square mile are ₹156 and ₹78.

376. During the year the finishing of the maps and records of the 4-inch skeleton survey of the Burdwan Raj estates which has been in progress for some years past was completed. The patch work of many seasons has now been combined and brought together in 9 main traverse circuits which are connected with G. T. Survey stations, and it is thus in true geographical position. The cost on this account from 1st October 1893 to completion of work was ₹8,138. This includes cost of preparing traces of the whole of the 4-inch maps for the Manager of the estates. These traces, which follow existing possession, are etained in the Survey Office for the present, as the Manager wishes the old revenue survey boundaries shown on the new maps.

The work performed during the season comprises the drawing of 64 fair sheets on the scale of 4 inches to the mile, the tracing of these 64 maps, the extraction of the areas of villages and the contained interests, and the final adjustment, completion and examination of the traverse computations.

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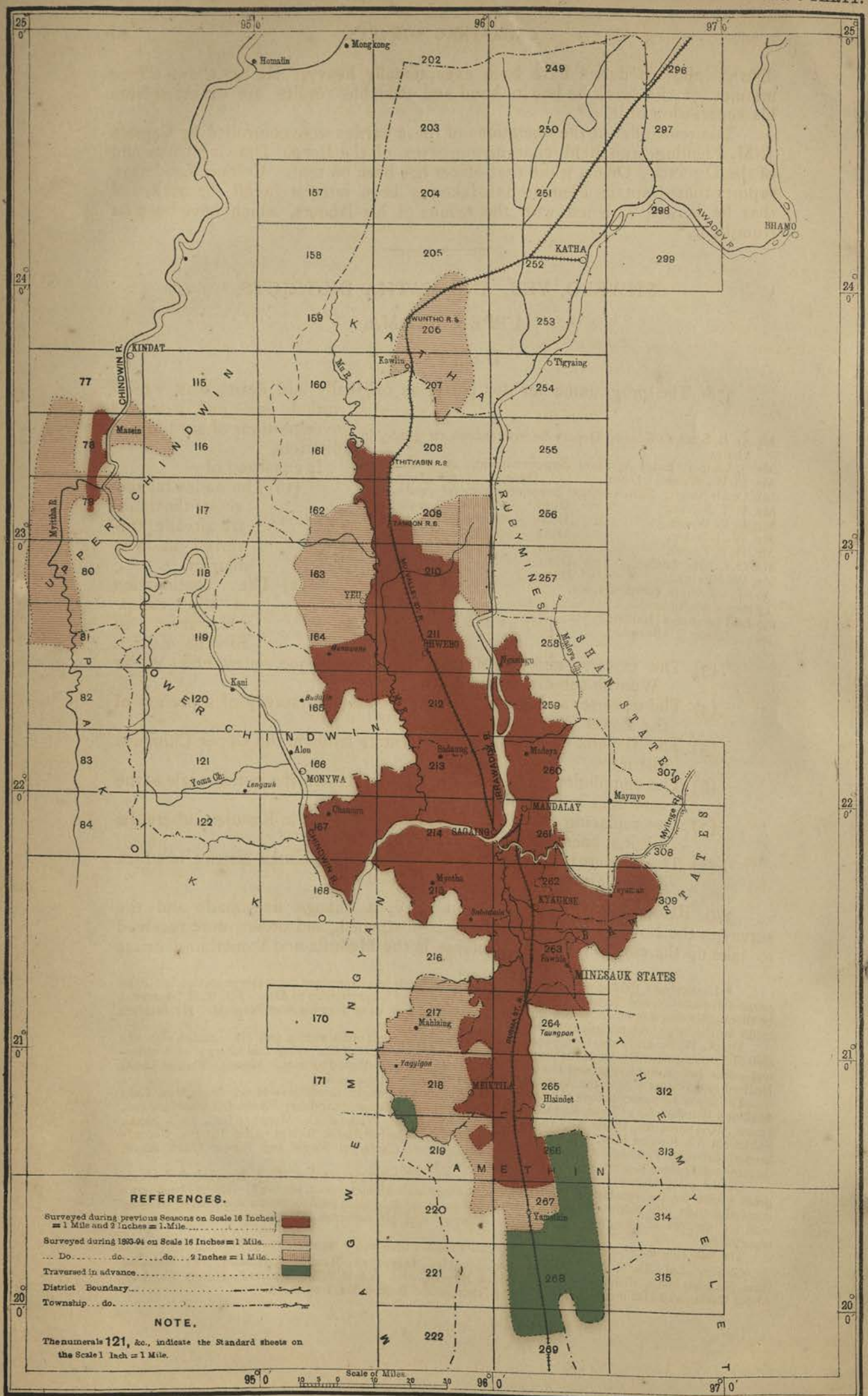
377. Lieutenant R. T. Crichton supervised the whole of the operations in the Champaran district and also the cadastral operations in the Saran and Gaya

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS SAGAING, SHWEBO, YAMETHIN, YEU, KATHA, MANDALAY, MEIKTILA, KYAUKSE, AND UPPER CHINDWIN.

1893-94. No. 3 PARTY.



REFERENCES.

Surveyed during previous Seasons on Scale 16 Inches = 1 Mile and 2 Inches = 1 Mile.

Surveyed during 1893-94 on Scale 16 Inches = 1 Mile.

... Do. ..... do. ..... do. ... 2 Inches = 1 Mile.

Traversed in advance.

District Boundary.

Township ... do.

NOTE.

The numerals **121**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

Reg. No. 484, S. I. D.—Jan. 95.—550.

Photo., S. I. O., Calcutta.

No. 320-S. 95.

districts and his duties have been exceptionally heavy. He has shown a true instinct for the work he has in hand and valuable results are expected from his supervision of it.

The remainder of the operations of these parties were controlled by Captain J. M. Fleming, who held charge, moreover, of the Bengal Drawing Office and of the Director's Office, while that officer has been on tour. Colonel Sandeman reports that Captain Fleming has taken a keen interest in all the work, and that he is well satisfied with the results of his labours, which have been far from light.*

SHWEBO, YEU, AND KATHA DISTRICTS, UPPER BURMA.

No. 3 PARTY.

378. The programme for this party, as originally laid down, was a most varied one, and extended over portions of six different districts.

Personnel.

Mr. G. B. Scott, Officiating Deputy Superintendent, 1st grade, in charge.
Mr. J. Connor, Extra Assistant Superintendent, 4th grade.
Mr. C. W. Wilson, Ditto Ditto 6th grade.
Mt. O. D. Smart, Sub-Assistant Superintendent, 1st grade.
Mr. P. J. Serrao, Ditto 2nd grade.
Mr. F. P. Walsh, Ditto 2nd grade.
Mr. W. J. Baker, Ditto 2nd grade.
Mr. H. B. Powell, Ditto 3rd grade.
Mr. O. C. Ollenbach, Ditto 3rd grade.
Mr. W. Newland, Ditto 3rd grade.
30 sub-surveyors, computers, etc.
13 inspectors (Indian).
130 field surveyors (Indian).
26 Ditto (Burman).

It consisted of—

(1) The cadastral survey of the country already traversed in Yeu district.

(2) The continuation of the cadastral survey in Shwebo district.

(3) The traverse and cadastral survey of about 300 square miles in the Wuntho sub-division of Katha district.

(4) The traverse, and perhaps also, the cadastral, survey of a portion of the Lower Chindwin district.

(5) The traverse and field survey of state lands in the Upper Chindwin district.

(6) The completion of the topographical survey on the 2-inch scale of the coal tract in Shwebo.

(7) The replacing of cylinders at traverse stations in Kyaukse, where the original ones had been lost or destroyed.

(8) The demarcation of certain blocks in the Katha district in which gold mining grants had been applied for.

379. Before field operations commenced, a change was made and the survey in the Lower Chindwin district was postponed, and orders were received to take up the completion of the surveys in the Meiktila and Yamethin districts

* Lieutenant Crichton reports that Lieutenant Symonds has supervised the traverse section in Champaran satisfactorily, and deserves credit for having the work of his section up to date. Mr. R. B. Smart can be thoroughly relied upon to obtain the maximum amount of work from his establishment. He deserves credit for the large area accomplished by his section.

Mr. A. W. Smart is also highly spoken of. The management of his section and his relations with the civil and other authorities leave nothing to be desired. Mr. G. T. Hall has never had charge of a cadastral section before, but has proved himself worthy of the charge entrusted to him. Messrs. Vander Beek, Bedford and Gasper among the Assistants, are also praised for their work.

The following names among the native establishment are brought to notice:—Head Inspectors, Lalji Mall and Kurshed Ali; Clerks, Raghubir Saran, Ori Lal and Banshidhar Ishri Pershad; Inspectors, etc., Imam Ali, Ahmed Ali, Waris Ali, Abdul Rauf, Riasat Husein, Wahidulhak, Manohar Lall, Lalji Sahai, Sakkamat Ali, Ramjas Misr, Ramkinker Pershad, Head Inspector Abdul Rahim, Abid Hosein, Record-keeper, Loknath Pershad, Accountant. Head Inspectors Chatarpal Singh and Inayat Ullah Khan, Accountant Moonee Kunny, Basit Ali and Hafiz Uddin.

Of the establishment working in Bengal, Captain Fleming reports that Mr. J. MacHatton deserves great praise for his constant attention to, and the care with which he does, his work. He has been more successful than any Survey Officer in the Province in utilisnig local establishments and thus dispensing with the services of foreigners. Mr. L. F. Berkeley and his assistant, Mr. Vaughan, are also well reported on.

The following members of the native establishment are favourably mentioned :—

Girdhari Lal, Abdul Majid, and Kalian Rae, Head Inspectors; Ramji Lal, Head-writer; Mahadeo Ram, Shambu Nath, Bishnpershad, Rakhaldas Banerji, and Wahid Ali, computers; Narain Pershad, Abdul Karim, and Hatim Ali, sub-surveyors; Abdulla and Rohim Bux, inspectors.

instead. When the surveys by local agency were stopped in Meiktila and Yamethin, the Deputy Superintendent was asked to employ as many as possible of the Burman field surveyors who were thus put out of employ. It was then too late to stop the *amins* coming from India; but as plots were supplied by the local survey, two Burman inspectors and about 40 Burman field surveyors were employed in Meiktila. Field operations commenced in the various districts during December 1893, and closed, except in Kyaukse, in May 1894.

Survey of the Yeu district.

380. In this district advance traversing had been executed over 750 square miles, and plots were ready for the field surveyors. Judging from the existing maps, it was supposed that with the exception of some narrow strips extending up valleys or among ravines, this would comprise the whole of the cultivable area of the district of which a survey was required; but during the progress of the survey it was found that there was a fairly large tract of cultivation extending northwards, and some strips also to the westwards. As, however, these portions were all undemarcated and no traverse surveyors were available without interfering with other work, it was decided to leave these areas until the next field season. The total cultivable area is now estimated to be about 1,100 square miles, of which 837 have been cadastrally surveyed during this and the previous year, leaving an area of about 250 square miles yet to be taken up. The bulk of the surveyed area is an open plain, entirely under rice cultivation during favourable years, but allowed to lie fallow when the rainfall is insufficient: the fields are as a rule large, and the place is well populated. The survey was easy and was completed before April when the field establishment were transferred to other districts. The detail survey completed during the season covered an area of 630 square miles, which was tested by 51 linear miles of check survey run by European assistants, and by 501 miles run by inspectors, besides 606 miles of independent *partal* lines: the results were good throughout.

381. The survey on the 16-inch scale was mapped on 762 sheets, which have been inked up, and of which tracings have been made for the Settlement Department, together with area statements.

382. It was found that, owing to the stringent orders on the subject issued by the Deputy Commissioner, Mr. R. C. Stevenson, the survey station marks had been most carefully preserved in Yeu, in marked contrast to other districts in Upper Burma.

Survey of the Shwebo district.

383. As no demarcation had been done in the still unsurveyed portions of Shwebo, the survey only extended over a few square miles which had been traversed in advance. The villages having been since demarcated, it is intended to complete the cadastral survey during the ensuing season.

Survey of the Katha district.

384. As soon as the state of the country permitted in December, a traverse camp was formed at Kawlin about the centre of the tract to be surveyed. It consisted of a flat irrigated basin dotted with numerous villages, about 15 miles long and 12 miles broad, with long, narrow strips running into the low hills and forests that surrounded it everywhere, except to the south where it adjoined Shwebo. The traverse work in the open part was easy, but along the outskirts and up the lateral valleys the lines had to be carried through bamboo and heavy forests. The traverse lines were connected with trigonometrical stations which had been fixed by the topographical survey party; but as the exact position of their stations had not been marked, and the observations were only approximate, no satisfactory checks on the traverse measurements could be obtained. This will be rectified next season, as it is intended to connect on to the stations of the trigonometrical survey which has since run a series near there.

Such of the gold mining and prospecting grants as lay within reach were incorporated in the traverse survey.

385. The detail survey of the fields was completed over an area of 226 square miles, but seven of the sheets, when checked, proved to be doubtful, and

will have to be re-surveyed next year: on account of the water again rising over the fields, it was impossible to do this at the time. The sheets were all tested on the maps themselves and in field books by the usual chain measurements.

386. The object of this survey in Katha was to facilitate enquiries regarding tenants' rights; and to enable Mr. Tydd, the officer specially appointed for the purpose, to carry out these enquiries, a list of tenants and plans of each holding were required, in addition to the survey of the fields and their areas which was all that was originally demanded from the surveyors. The Deputy Superintendent, seeing that a special staff of men would be required to go over the surveyed area a second time in order to mark out the holdings and make the required lists, which would cause great loss of time and extra expense; directed the Burman field surveyors to mark off the holdings and make a register of the tenants' names without touching on questions of tenure. This was done, and on Mr. Tydd's arrival he was furnished with tracings, showing field limits in thin lines and holding limits in thick lines, together with a list of tenants, the areas of holdings, and the number of fields in each holding. Mr. Tydd acknowledges that these were of the greatest use to him, and reported that they were on the whole very accurate.

387. The early rains flooded the country before the middle of May and stopped all work; the detachment was then withdrawn, and not a day too soon, as both European officers and several of the natives have suffered severely from fever since. There still remain several circles where disputes regarding tenure exist, as well as others in which there are undoubted State lands, and these will be surveyed during the coming season. It is impossible even to conjecture what the area of these may be; they lie in different villages scattered over a large area, the greater part in narrow strips among forest clad hills.

Survey of the Meiktila district.

388. As previously mentioned, the survey in the Lower Chindwin district was postponed, and orders were received to substitute for it the completion of the surveys in the Meiktila and Yamethin districts.

389. Of the plains portion of Meiktila, the *sisa* or royal lands covering an area of 577 square miles, had been cadastrally surveyed by this party in 1890-91: since then a further area of about 90 square miles of irrigated lands had been completed by the local survey party, and advance traverse work had been carried over another 80 square miles. The work by the local agency was then stopped and the completion of the survey of this district was made over to the professional survey party. Plots of the villages which had been traversed in advance were made over by the local survey party.

390. The advance traverse survey which had been executed by the local agency had been started from the stations of the *sisa* lands survey, and the origin and data of that work was adopted; but it was found that the sub-traverse lines were too far apart to afford a sufficient check to errors in chaining, and that the stations were too few for the field surveyor to base his work on with accuracy; the angular work had not been checked by azimuth observations, and so many errors in the chain measurements were reported by the field surveyors that the European officers had on several occasions to go and correct the plots themselves. To prevent the chance of errors extending into the portion about to be taken up, the outer traverse lines done by the local party were re-traversed. The boundaries of 52 *daings* or circles were traversed and 908 sub-traverses were run.

391. The sub-division of these *daings* into *kwins* or villages had not been done when the survey commenced, so that traverses could not be run along them; the demarcation was carried on during the progress of the survey and the boundary pillars were taken up and entered on the maps by the field surveyors. This entailed much extra office work, as while the survey is necessarily made by circles, the tracing, field numbering and area estimating must be done by *kwins*, so tracings from the original sheets had to be made for reproduction instead of sending the originals themselves. Both field and office work was also increased by the action of the demarcation officers: in parts they marked out blocks averaging scarcely a quarter of a square mile in area instead of one square mile as required by the Boundaries Act; in other places the demarcation

pillars, when in cultivation, were not placed at the angles of the holdings. The field surveyor had thus to follow the field limits nearest to the line joining the pillars, and the boundary line thus formed was as often as not found by the Settlement Officer to cut through holdings; this necessitated alterations in the *kwin* tracings. To show how much time was thus lost, it may be mentioned that the reproduction of the sheets of the *sisa* lands survey of 1890-91 is only now being made.

392. There were 11,098 stations fixed with the theodolite, at each of which was embedded a glazed clay cylinder; these were purchased at R12 per hundred instead of R19 as in 1889 in Kyaukse; the cost of these now is, therefore, not much more than that of the zinc pipes used in other parties, and there is no doubt as to their durability.

393. Including the area prepared in advance by the local party, an area of 820 square miles was cadastrally surveyed; every sheet was checked by traverses run independently and entered in field books as well as by chain lines run on the board plans themselves. The total length of check lines was 942 miles, of which 95 were run by European assistants, 608 on the board plans by inspectors, and 239 in field books: a few sheets were found incorrect and were re-surveyed. About 40 per cent. of the area surveyed is under cultivation. There remains for field survey an area of about 80 square miles which has been traversed in advance.

Survey of Yamethin district.

394. The local survey party had completed the field survey of about 200 square miles and had traversed about 200 square miles in advance in this district. It lay chiefly along the line of railway and is almost all under irrigation. As the early survey of these tracts was of importance, three squads of *amins* were transferred from Yeu; they completed 132 square miles of cadastral survey on the traverse plots received from the local survey. The plots of 70 square miles more were either not supplied or were returned owing to the insufficient number of traverse stations; the traverse survey work by the local survey was similar in quality to that in Meiktila, but there were even fewer stations. Advance traverse work was carried on over 350 square miles, based on the outer lines of the local survey after they had been checked as in Meiktila. The total number of theodolite stations fixed was 6,801, cylinders being embedded at each station.

395. The continuation of the traverse and cadastral survey of this district will form the principal item in the programme for next year.

Survey of the State lands in the Upper Chindwin district.

396. The Deputy Commissioner of this district having very strongly urged the necessity of having a survey made of certain lands in that district where questions of State rights were likely to form subjects of dispute, it was at first arranged that a small detachment of field surveyors should be handed over to that officer to carry out the survey under his directions, it being believed that it would be impossible for Mr. Scott to undertake more work than had been already given him. No amount of work, however, apparently being too much for that officer, he proposed that it should be incorporated in his programme, and there being no European officer available, he undertook to see to its being properly carried out himself; for manifest reasons it was much better that the work should be done once for all on a correct basis and Mr. Scott's offer was at once accepted.

397. The areas for survey lay in the Masein and Kalé valleys, and mainly consisted of a central strip of cultivation with narrower strips running up the lateral valleys. In the Kalé valley the cultivated portions lie almost entirely on the east bank of the Myitha river, the inhabitants having been driven across by the frequent incursions of the Chins. There being no traverse work in advance and no time available for the traverse surveyors to get ahead of the field surveys, the following method was adopted:—A series of flags was aligned at distances of about 12 chains apart down the strips of cultivation, and on these quadrilaterals were built, of which both diagonals were measured; cylinders were embedded at these flagged stations and at the corners of the quadrilaterals, and these were afterwards adopted as traverse stations by the sub-surveyor who followed. Subsequently the circuits, and traverse lines were set up and plotted, and

the survey of the fields was transferred to these correct plots: as the cultivated lands never extended to any great distance on either side of the central line of flags, no difficulty was found in fitting the field work into the plots.

398. After the field survey was completed, Burman *amins* were told off as was done in the Katha district, to accompany the tenants round the fields to mark off the limits of the holdings; and at the same time to make a register of the names of tenants and sub-tenants, of the holdings (each of which has a distinctive name), and the number of fields in each holding: the areas of holdings were subsequently entered. As soon after as possible, tracings of the maps and copies of the registers were made over to the Deputy Commissioner. In Masein the number of hamlets surveyed was 39; the area of holdings as reported by the *thugyis* was 1,750 acres, whereas the actual area by survey was found to be 6,471 acres of land actually under crop, besides 385 acres lying fallow, or four times the reported area. In the Kalé valley the lands of 53 hamlets were surveyed, giving an area of 68 square miles, of which probably half is under crop and the bulk of the remainder is fallow.

399. The survey next season is to extend northwards up the Chindwin river, taking up all the villages declared to belong to the State up the Kubo valley, and all villages in the Legyaing sub-division. It is supposed that the total area of cultivable land will not fall far short of 1,000 square miles, but it is impossible to say what reliance can be placed on this estimate.

Topographical survey of coal tract in Shwebo.

400. The topographical survey, on the scale of 2 inches to the mile, of the coal tract in the Shwebo district was completed, and the fair maps have been sent to Calcutta for reproduction. The area surveyed was 183 square miles. It was a very difficult and intricate piece of work, the country consisting of low spurs much cut up by ravines and covered with dense forest. It was checked by a theodolite and chain traverse run from north to south through the three sheets, vertical angles being observed at each station; thus not only was the drainage checked, but a series of heights was obtained, on which to base the contouring and also to fix the actual heights above the sea of certain selected points. The cost-rate of this small area of topographical survey was R21-8 per square mile.

Traverse survey of the Kyaukse district.

401. A small detachment of field surveyors and a couple of traverse surveyors were directed to replace cylinders at the traverse stations in Kyaukse, where they had been destroyed or lost since the survey was made in 1889-90, and to fix others where, owing to the want of cylinders at the time of survey, it had been impossible to permanently mark a sufficient number of traverse stations on which to base revision surveys. When the traverse survey was originally made, the country was in a disturbed state, and the District officers were unable to attend to such matters as the preservation of survey marks; the consequence was that many were lost or removed: when the Burman *amins* of the local survey were sent to search for the traverse stations, they reported that 90 per cent. of them were not to be found. The detachment from this party with the cadastral sheets in hand discovered quite 50 per cent. of the missing stations. New cylinders were embedded at those stations at which the old mark was found broken, whilst new stations were fixed along village boundaries where necessary. By the end of April, cylinders had been embedded at all required points in three out of five townships. They could not be completed in the fourth township, owing to the country becoming flooded and so some 12 or 13 villages remain to be traversed. The fifth township would have been completed, had it not been for the stupidity of some Burman surveyors, who were sent to assist in searching for the old stations in the hope of getting the whole work done more quickly. Instead of doing as they were told they laid down new stations round every village, and on Mr. Powell, who was supervising this work, going to examine what had been done, he found old and new stations all intermingled, so that an entire re-traverse was necessary. There remains, however, very little to complete this work in the district, and it will be quickly finished when the country dries up in the coming cold weather. A copy of each cadastral sheet, showing both the new and the old stations, has

been made over to the Deputy Commissioner. The total number of permanently marked stations now amounts to 8,140.

Survey of gold mining grants in Katha.

402. But very little could be done in demarcating or surveying these grants owing to the absence of the applicants. Traverses were run and stations were marked with cylinders near the outer limits of one prospecting and four mining grants, but in the absence of the applicants, and of any marks to show the exact positions of the ground asked for, it was impossible to lay down the exact boundaries. These can be placed next season, with the help of the traverse stations, as soon as the applicants point out their exact requirements. Some applications were received too late to be demarcated this season.

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403. The total out-turn of work for the season in all the different districts is shewn in the following statement :—

Localities.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile.			Topographical Survey, 2-inch scale.	Remarks.
	Number of villages.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles	Area in square miles.	
Yeu	...	...	216	402,465	630	...	
Shwebo	...	...	4	3,102	47	...	
Katha	129	393	98	203,019	226	...	
Meiktila	1,016	728	1,016	427,095	820	...	
Yamethin	*Not known.	350	*Not known.	106,226	132	...	* Villages were not demarcated.
Upper Chindwin	92	103	92	118,087	103	...	
Shwebo coal fields	...	...	...	...	...	183	
Katha gold fields	...	2	...	...	...	...	4 mining blocks. 1 prospecting grant.
Total	1,237	1,576	1,426	1,259,994	1,958	183	

404. The average size of the field over the whole area is almost exactly 1 acre.

405. The large area surveyed, which is nearly 200 square miles in excess of the previous year's out-turn, is owing to the large number of Burman *amins* entertained in addition to the original establishment. This upset the balance of the party and the number of field surveyors became too large in proportion to the number of traverse surveyors and the traverse work could not be kept sufficiently ahead. Moreover, the detail survey has progressed too fast for the Settlement Department, and orders have been received to reduce the annual out-turn in Upper Burma.

406. The cost of the operations varied considerably in the districts under survey owing to the different conditions under which the survey was made; for instance, in Yamethin, where the country was open and easy, the cost-rate of traversing was less than $\frac{1}{2}$ anna per acre, whilst in Katha and Meiktila, where the country is covered with jungle or broken up by ravines, the rate rose to 1 anna 5 pies and 1 anna 8 pies, respectively. The average cost of the traverse operations amounted to just 1 anna per acre. The average aggregate cost of the survey including detail survey, traversing, completion of maps, and area estimating amounted to 3 annas 6 pies per acre. This is somewhat higher than the average rate of last year which was 3 annas 2 pies per acre; the reason of this increase is due to the excessively scattered nature of the work and the smaller size of the fields.

407. Again this year local labour was extensively used in place of *khalásis* imported from India. In every district men or boys were obtained who would work in their own villages at the usual rate of 4 annas a day in the open country or 8 annas in heavy tree forests where much cutting had to be done, as in the gold mining tracts in Katha.

408. Nowhere was there any friction between the villagers and the survey employés. Except during the visits of the Deputy Superintendent, the Indian surveyors working in the Upper Chindwin, were quite away from all European supervision, but even so there was not a single complaint made against them. Mr. Scott is of opinion that the Indian surveyors get on better with the inhabitants than the Burman *amins* do. He himself invariably met with civility; when on tour in the north-western portion of the Katha district, the *thugyis* often came half a mile from their villages to meet him and voluntarily cleared the roads from village to village for him.

409. At the suggestion of the Financial Commissioner an attempt was made to induce more Burmans to join the party to receive a course of training in surveying. In the Yeu district, 14 men joined the survey camp, some remaining only one month, while others continued for three or four months. In the Upper Chindwin one young boy, son of a *thugyi*, was trained both in the field and in recess, and another marched right into Mandalay from beyond Kindat to join the party. Both these young fellows intend to remain with the party next year.

410. The health of those working in the southern districts was good, but in Upper Chindwin and Katha districts the cold damp fogs which are very frequent up till 9 or 10 in the morning, caused a good deal of fever. As these died away, the country became healthier; but the early rain in May again brought on fever, prostrating many of the men and necessitating their withdrawal from the field.

411. During the recess the following 16-inch cadastral sheets were inked in, and tracing and area statements have been prepared or are under preparation for the Settlement Department, *viz.*, in Yeu 762 sheets, Shwebo 46 sheets, Katha 282 sheets, Meiktila 710 sheets, Yamethin 161 sheets, Upper Chindwin 105 sheets; or 2,066 sheets altogether. Topographical maps have either been prepared or are in hand by reduction from the above cadastral sheets to the 2-inch scale, for publication on the 1-inch scale in standard form. Tracings of the 2-inch standards of the Sagaing district and of the *sisa* lands in Meiktila have been prepared and given to the Department of Public Works, and others of Shwebo have been made for the Financial Commissioner. Topographical maps on the 4-inch scale of Shwebo and Sagaing are also under preparation for the Irrigation Department. Plots of four gold mining and of one gold prospecting grant in Katha and of Mr. Calogreedy's grant in Sagaing were given to the Financial Commissioner.

412. It will thus be seen that the work done both in recess and the field by this party, under Mr. Scott, is of the most varied description. There are not many, if any, officers in the department who could undertake so many different kinds of work scattered over so large an area, and carry them all on satisfactorily. Mr. Scott has not only had great professional experience but he is also endowed with unlimited energy, indomitable pluck, and plenty of common sense. It will be very difficult to replace him in Upper Burma, now that he is to be transferred to the North-Western Provinces.

413. The Deputy Surveyor-General inspected the party during the field season, visiting the head quarters office at Mandalay, and then making a tour with Mr. Scott through the cadastral work in Katha and the coal tract in Shwebo. He has expressed his entire satisfaction with everything he saw.*

* In consequence of the scattered and varied nature of the work, the greater number of the assistants were in more or less independent charge of camps. Mr. Connor supervised the greater part of the cadastral work, Mr. C. W. Wilson the traverse work in Meiktila and Yamethin, Mr. O. D. Smart the traverse and cadastral work in Katha, Mr. P. J. Serrao the cadastral work in Meiktila, and Mr. W. J. Baker that in Yamethin; Mr. F. P. Walsh supervised the topographical survey in Shwebo and Mr. H. B. Powell the re-marking of traverse stations in Kyaukse; Messrs. O. C. Ollenbach and W. Newland supervised the field surveyors. The Deputy Superintendent reports that he can, with the utmost confidence, entrust each assistant with any work required, however difficult and at whatever distance from head-quarters it may be, without the slightest misgiving that it will be done to the utmost of his ability.

Among the Native establishment Mr. Scott specially mentions his writer and Pundit Kedar Nath, the senior computer, and Sub-Surveyors Rohan Lall, Surfraz Khan, Mahomed Shaffi, Abdul Hasan and Rafatulla.

BIHAR.

NOS. 4 AND 5 PARTIES.

414. These parties continued the survey of Northern Bihar, in the Muzaffarpur, Darbhanga, and Saran districts, and also furnished detachments for the traverse survey of the Tikari Ward's Estate, district Gaya, and for the Kachnar Mahal boundary survey, district Shahabad. The charge of the parties was held by Captain G. B. Hodgson, S.C., Deputy Superintendent, 1st grade, except for a period of one month while he was absent on privilege leave, when Mr. J. S. Pemberton held the charge.

The operations in each district will be described separately.

Survey of the Muzaffarpur District.

415. The traverse survey of this district was completed last season, but throughout the present season the computations and plotting in connection therewith have been in progress, no attempt having been made hitherto to keep them abreast of the field work, as there was no necessity for it, the area traversed being well in advance of the cadastral survey. These arrears have now been completed and skeleton plots of the entire district are ready for cadastral survey.

Personnel.

Mr. H. T. Hanby, Extra Assistant Superintendent, 3rd grade.
„ C. S. Kraal, Sub-Assistant Superintendent, 1st grade.
„ P. C. H. Smart, Sub-Assistant Superintendent, 1st grade.
„ C. G. Lee, Sub-Assistant Superintendent, 2nd grade.
„ H. H. B. Hanby, Sub-Assistant Superintendent, 3rd grade.
1 supervisor.
44 inspectors.
200 imported *amins*.
200 local surveyors.

Owing to the *parganas* being very much intermixed, it has been impossible to take the main traverse circuits along their boundaries.

416. The expenditure incurred this season in connection with the traverse survey of Muzaffarpur amounts to Rs. 6,805, which brings the total cost of the traverse survey of the district, from the 1st October 1891 to the 30th September 1894, to Rs. 99,730 for an area of 2,244 square miles. This gives an average cost-rate of Rs. 44·4 per square mile. The cost of the traverse survey in this district has been greatly enhanced owing to the inclusion of the pay and allowances of two Assistant Superintendents, Lieutenants Pilcher, R.E., and Symonds, I.S.C., who were under training during the previous season on appointment to the department, and were employed on the traverse survey.

417. During the past season two sections have been employed on cadastral survey in the Muzaffarpur district, and the programme laid down for each of them was to complete an area of 500 square miles. The section under Mr. Hanby took the field during the last week of October, but the other section did not arrive from Orissa till the end of October, and then establishments had to be engaged, instruments given out, etc., so that it was not till the middle of November that the field work was fairly commenced.

418 As mentioned in paragraph 341 of the General Report for 1892-93, orders were received early in August 1893 that *patwáris* were not to be employed in the survey and settlement operations in Bihar, and that establishments of local men were to be trained in survey and record-writing for the work in the ensuing season. Under these orders 200 men belonging to Bihar were trained, as far as was possible in the short time left before the field season, and 200 *amins* were engaged from the North-Western Provinces to make up the 400 men required for the area it was proposed to survey.

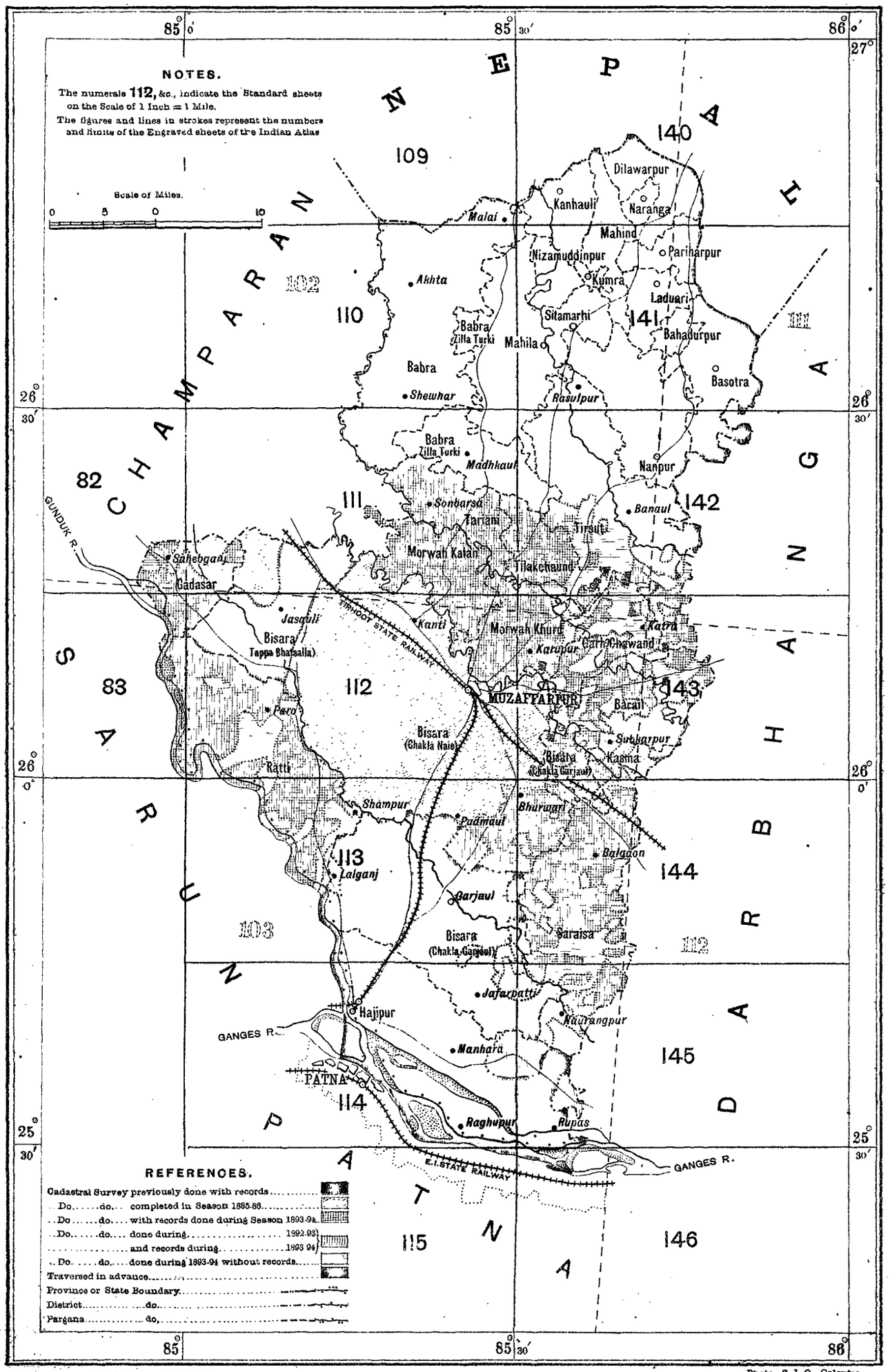
419. The out-turn of cadastral survey and record-writing for the season is as follows:—

District.	Cadastral Survey, 16 inches = 1 mile.			Record-writing (Khanapuri).		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Muzaffarpur	1,594	1,375,509	979	1,365	1,151,684	788

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MUZAFFARPUR.

1893-94. Nos. 4 & 5 PARTIES.



Reg. No. 502, S. I. D.—Jan 95.—1,763.

Photo., S. I. O., Calcutta

No. 308-S. 95.

420. The area surveyed extends over nearly the whole of the Muzaffarpur sub-division, excepting *tappas* Bhatsala and Chakla Nai of *pargana* Bisara, which were for the most part surveyed in 1885-86. It also includes the portion of *pargana* Ratti lying in the Lalgunge *thana* of sub-division Hajipur, and the whole of *pargana* Tariani in the Belsund *thana* of the Sitamarhi sub-division.

421. The out-turn of record-writing includes an area of 61 square miles, which was surveyed in the previous season, and thus the record-writing is behind the field survey by 252 square miles.

422. In addition to the out-turn of *khanapuri* given above the records were written of portions of 52 villages, the number of fields being 46,079. This unfinished work has not been taken credit for. The surveyed area of 979 square miles includes 15 square miles of the bed of the Gundak river, below banks. An overlap of 20 square miles of the river bed belonging to the Saran district was also surveyed on the 16-inch scale, but this area will be included in the out-turn of that district when it comes under survey.

423. The failure to work up to the programme is partly due to the fact that half of the establishment was entirely new to the work, and consequently their progress was generally extremely slow at the commencement of the season; but it is due in a greater measure to the difficulties encountered in the numerous *pattidari* villages in Muzaffarpur, in securing the attendance of the very large number of proprietors, to the innumerable disputes, the complicated tenures, and the minute sub-divisions of the *mahals* (the *khewat* sometimes being as long as the *khasra*). On these accounts the establishment was insufficient for the area. In future, 250 *amins* will be allowed for 500 square miles instead of 200 men among *pattidari* tenures.

424. Another circumstance that would have rendered the completion of the programme an impossibility was that a large portion of the country was inundated at the commencement of the field season owing to the heavy and late rains, and as it was invariably the larger villages that were thus affected, it was not till towards the close of the season that the survey of these could be taken in hand, and consequently the *khanapuri* could not be done.

425. The number of disputed entries was exceptionally large, and consequently, under the orders introduced this season, much of the time of the inspectors was taken up in writing their orders in the dispute lists. Thus the progress was interfered with; for it often happened that until an *amin* had received orders from the inspector, he was unable to proceed with the *khanapuri*, because the dispute affected the numbers to be entered on the map, that is, it was doubtful whether a plot should receive one or several numbers.

426. One inspector and several *amins* of his circle had to be dismissed for dishonest practices, which made matters worse, as they were all up-country men and fast workers. With regard to this episode, Captain Hodgson writes:—"The possibility of men attempting to indulge in such practices will be increased enormously if the European supervision is reduced to only one assistant besides the section officer. In Muzaffarpur, which consists almost entirely of *pattidari* villages, it is impossible for two officers to supervise efficiently so large an area as 500 square miles, if they are to be of any assistance in checking the *khanapuri*; for it must be borne in mind that the control of the large body of men required is entirely in the hands of the section officer of the Survey Department, on whom also devolves the troublesome task of securing the attendance of unwilling landlords."

427. The season's work has been mapped on 2,041 sheets, of which only 1,456 are entirely completed, the *khanapuri* of the rest not having been accomplished this season. There were 121 sheets of 93 villages surveyed last season, which were then left incomplete, owing to the *khanapuri* not having been done. The record-writing of 91 of these villages on 120 sheets has been done this season and the maps completed.

428. The average size of the villages of which the records have been written during the season is 0·57 of a square mile. They range from 7 and 8 square miles to one or two acres. The average size of the field in the area completed is 0·43 of an acre.

429. The season's survey was tested by 3,745 miles of check survey, of which 265 miles were check lines run by the European assistants on the plans, 1,240 miles were independent checks, carried out after the maps were lodged in

office, and 2,240 miles were run by native inspectors. This gives an average of nearly 4 linear miles of test work to every square mile of survey. The number of *khasra* entries checked by the European assistants of the Survey Department is 21,431, and by native inspectors 203,098; altogether over 19 per cent. of the total number of entries.

430. The number of boundary disputes submitted for the decision of the Revenue officers was 561, of which 430 had been decided by the end of the season. When a dispute is disposed of the trace is returned to the Survey office to enable the original maps to be completed.

431. At the end of May the camp offices were moved into recess quarters at Muzaffarpur and at Dinapore, so as to enable a commencement to be made with the preparation of the traces and statistical papers, though field work continued till nearly the end of June, up to which time the European assistants remained under canvas.

432. There was no marked sickness this season until April, when cholera broke out in a portion of the area under survey, but fortunately was confined to only a small tract. Much difficulty was then experienced in keeping the *amins* at their work and also in getting the people to attend to point out their lands.

433. Notwithstanding the fact that the entire establishment, including the majority of the native supervising staff, were new to the work of completing the records, there are now no arrears, for which Messrs. Hanby and Kraal deserve great credit. At the commencement of the recess season it was intimated that new forms were to be employed for the *milan khasra* and crop statements. New forms were not received till the end of recess, and the statements were prepared in the old forms, the headings being changed by hand, which has entailed a vast amount of labour.

434. The cost has been ₹65,441 for survey and ₹61,664 for records, the rates for the season are (1) survey, including completion of maps, ₹68·4 per square mile, and (2) record-writing, field and office, ₹78·1 per square mile, or an aggregate rate of ₹146·5 per square mile which is ₹9 less than the rate of the previous season for the same operations. In over 75 per cent. of the villages the chainmen were furnished by the *zamíndárs* and received no payments from the Survey Department.

435. Next season two cadastral sections will continue to work in this district: one section will be employed on the revision of the maps and records of the area surveyed in 1885-86 under Colonel Barron and in completing all the gaps left by the two sections during the season under report; the second section will take up a fresh area of 500 square miles to the north of the present season's work, and which approximately comprises the southern half of the Sitamarhi sub-division up to a line drawn nearly east and west through Sitamarhi.

436. The Director of Bengal Surveys inspected the sections operating in the Muzaffarpur district in the end of October 1893, in February, March and April 1894 in the field, and from 8th to 20th July 1894 in recess.

Survey of the Tikari Ward's Estate, District Gaya.

437. During the previous season the larger blocks to the north and to the south and south-east of the Gaya city, having an area of 271 square miles, had been traversed by a detachment of No. 2 Party. The remainder of the villages of this estate, with an aggregate area of 334 square miles, were scattered either in small groups or as isolated villages all over the district. The system of running main and sub-circuits had therefore to be abandoned and the several groups of villages were connected by traverse lines limited in extent by the situation of villages, so as to afford an area of about 10 square miles in each block. In two instances villages were too far removed from any of the traverse blocks to be conveniently connected.

Personnel.

Mr. J. S. Pemberton, Assistant Superintendent, 2nd grade.
Mr. W. J. O'Sullivan, Extra Assistant Superintendent, 3rd grade, from 1st May 1894.
Mr. S. O. Madras, do. do. do. 5th grade, up to 30th April 1894.
30 sub-surveyors.
20 computers.

438. In order to expedite the traverse work and have the plots ready in time for the detail surveyors, 30 traverse surveyors were employed and 10 square

miles were allotted to each man. It was expected that the traverse work would thus be completed in one month, but owing to unforeseen difficulties it was not brought to a close till the end of February, though the bulk of the field work was finished by the 15th of November and the plots with few exceptions were completed and made over to the cadastral section by the 15th December.

439. Traverse operations had to be started on the 1st October 1893, much earlier than usual, as the cadastral survey of the whole area was to be carried out during the current season. The account of the cadastral operations will be found under the head of Nos. 2 and 8 Parties by which it was executed.

440. The out-turn covered an area of 334 square miles and comprised 2,272 linear miles of traverses checked by 64 azimuths, the theodolite being set up at 10,851 stations. There were also 800 sub-traverses run, the stations of which were fixed on field boundaries. The number of village circuits traversed was 496: it was subsequently brought to light that in 15 of these, covering an area of 7 square miles, the estate had no interest.

441. Observations for azimuth were taken to east and west stars and the sun at convenient points in each block, averaging 10 to 12 miles apart. The mean magnetic variation of the needle for this district was found to be 2° 7′ east. The angular error as checked by azimuth amounts to 1 minute in every 12 angles; the nature of the work prevents a comparison of the linear error with trigonometrical data. Two principal stations, however, of the Chendwar Meridional Series have been connected, *viz.*, Job Makanpur T. S. and Lohawa H.S.

442. All village tri-junction points were permanently marked by dressed stones procured from the Bengal Stone Company, or by 8-inch pottery cylinders, and all other traverse stations on the village boundaries with glazed 2-inch pottery cylinders. The stations on the connecting lines were marked with wooden pegs. All the cylinders were supplied by Burn & Co. of Raniganj. The number of permanent marks used were—

Cut stone prisms	470
Pottery cylinders, 8-inch	490
Do. do. 2-inch	6,120

443. The demarcation of village boundaries was carried out, as in Northern Bihar, by the *zamindárs* themselves, immediately in advance of the traverse survey, but it was done in a very perfunctory manner. The main difficulties met with were (1) the country for the most part being under water when the work was started, which rendered the carriage of permanent marks very difficult and slow and caused a great deal of sickness, (2) the scattered nature of the work, both of which causes delayed progress considerably. No marked obstruction on the part of the inhabitants was experienced.

444. The cost of the season's traverse survey of the estate is ₹14,240, giving a rate of ₹42·7 per square mile, which is ₹15·8 less than the rate of the previous season.

Survey of the Saran District.

445. The traverse survey of this district was carried on in continuation of last season's operations. As each field surveyor completed the work allotted to him in the Tikari estate, he was transferred without delay to the Saran district. In this way the season's work in Saran commenced about the 15th November 1893, and was closed on the 15th March 1894. The camp office moved from recess quarters at Dinapore to Siwan in Saran on the 1st December, the work in the Tikari estate having been supervised from Dinapore.

446. The following statement gives the out-turn of traverse survey:—

District.	Traverse Survey.			
	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Saran	1,721	1,992	20,045	932

In addition to the above work, 178 extra sub-traverses were run in the area traversed during the previous season. The main traverse circuits have been run along *pargana* boundaries, except on the Ghogra river, where they follow for the most part the limits of the overlap survey of the Ballia district made in 1881—85. Two chains of 93 and 100 links were used on every main and sub-traverse circuit.

447. The angular measurements were checked by azimuth observations at 101 stations. The angular error was found to be 1 minute in 13 angles, the theodolite having been set up at 20,045 stations. The mean magnetic variation in the district was found to be 2° 14' east. Only two principal stations of the G. T. Survey, *viz.*, Katwarpur T.S. and Jalalpur T.S. of the Hurilaong Meridional Series, fell within the area surveyed, and these were connected, proving the error of the chaining to be 3·1 feet per mile.

448. All tri-junction points of villages have been marked either with dressed stone prisms or large earthenware pottery cylinders, the former supplied by the Bengal Stone Company, and the latter by Messrs. Burn & Co. of Raniganj. All other traverse stations have been marked with baked clay cylinders manufactured at Dinapore at a cost of about ₹5 per hundred. The number of each description is as follows :—

Large pottery cylinders	2,800
Stone prisms	440
Baked clay cylinders	16,500

449. The usual dilatoriness on the part of the *zamindárs* in demarcating their boundaries, as experienced in preceding seasons, was again the cause of much delay and trouble. Though the necessary notices were issued more than a month before the line-cutters came on the ground, boundaries in numerous cases were reported as wholly undemarcated.

450. The cost of traverse survey during the season has been ₹34,273, and the rate Rs. 36·8 per square mile, which is ₹1·8 less than the rate of the previous season.

451. There are now 796 square miles remaining for traverse survey in Saran, of which it is intended to complete about 500 square miles during the coming season. Nearly 200 square miles consist of *diára* lands which are subject to fluvial action, and therefore cannot be traversed until the season of cadastral survey.

452. The Director of Bengal Surveys inspected this section in the field on the 1st and 7th March, and in recess early in July 1894.

453. The cadastral survey of the Saran district is being carried out by Nos. 2 and 8 Parties, and these operations will be found described in the report of those parties.

Survey of the Darbhanga District.

454. The establishment of the traverse section in the Saran district was transferred, on the completion of its allotted work there, to the Darbhanga district for similar work.

455. The area taken up for traverse was the north-west corner of the district, comprising the whole of *thana* Benipatti, 284 square miles (381 villages), and the northern half of *thana* Darbhanga, 234 square miles (310 villages). These areas were completed, giving an aggregate out-turn of traverse work of 518 square miles (691 villages). The number of linear miles traversed was 2,040 and the theodolite was set up at 10,107 stations.

The main circuits in this district were run along *thana*, and not *pargana* boundaries, the former being more compact and not intermixed, as the latter invariably are.

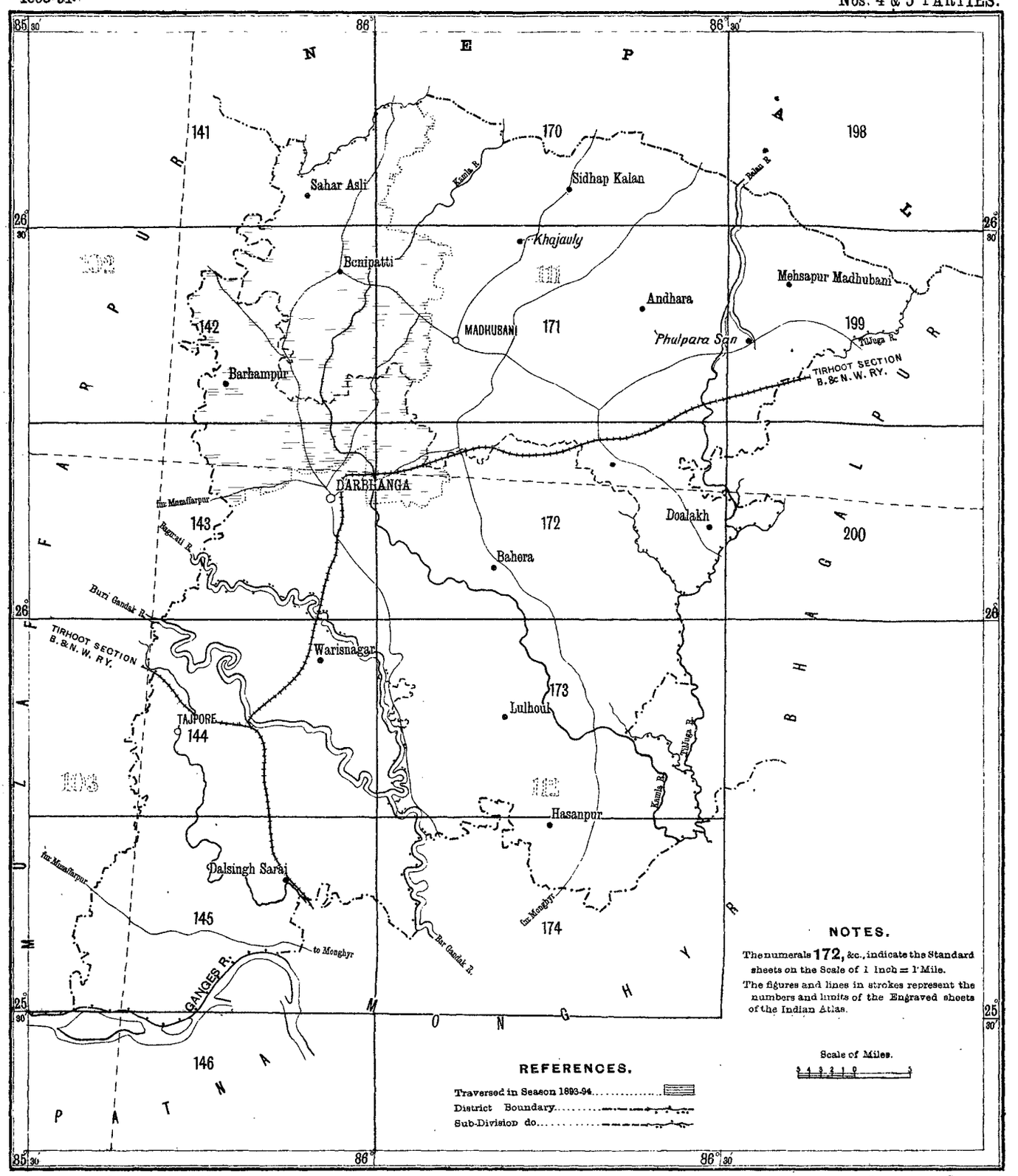
456. Azimuth observations were taken on all main circuits and sub-circuits at every 30 to 35 stations apart, and always at the junction of main and sub-circuits. The number of azimuths observed was 51, and the average angular error of the traverse work as checked by them was found to be 1 minute to every 12 angles. The mean magnetic variation is 2° 57' east.

457. All tri-junction points were marked by cut-stone prisms, of which 1,245 were used. All other traverse stations except those on disputed boundaries

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT DARBHANGA.

1893-94. Nos. 4 & 5 PARTIES.



NOTES.

The numerals **172**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

REFERENCES.

Traversed in Season 1893-94.....

District Boundary.....

Sub-Division do.....

Reg No. 481, S. I. D.—Jan. 95.—1,752.

Photo., S. I. O., Calcutta

No. 307-S. 95.

were marked by locally-made baked clay cylinders, of which 8,800 were used. The latter cost R4-8 per hundred.

458. The cost of the traverse survey has been R16,340 and the rate for the season's work is R31·6 per square mile.

459. The demarcation was well in advance of the survey, and was carefully and satisfactorily carried out, especially of those villages in which the Darbhanga Raj had interests. Owing to the cordial assistance of the Raj sub-managers, Messrs. R. Crookshank and R. S. King and Babu Gongadhur Gosain, the work progressed without check throughout.

460. On the completion of the Darbhanga programme the traverse section moved into recess quarters at Mussooree at the end of April 1894.

461. The Director, Bengal Surveys, inspected this camp in March and in August 1894.

Survey of the Kachnar Mahal Boundary, Shahabad District.

462. In *pargana* Rhotas in the subdivision of Sassaram, in district Shahabad, Government possesses a property, known as the Banskati *mahal*, in which it has the right to levy certain dues; the limits of this area have never been clearly defined. Within it, but forming no part of it, is a private estate called the Kachnar *mahal*, of which the area, by the survey which has just taken place, is 16,693 acres, or 26·08 square miles, while by the survey of 1845 it is 16,620 acres, or 25·97 square miles. It was stated to be 40 square miles in Government letter No. 1907 For., dated 18th April 1893, in which an estimate for the survey was required.

463. Owing to the undefined boundaries of this *mahal* there has been continual friction between Government and the proprietors thereof, and a settlement of the Government property has been impossible while there was uncertainty as to its boundaries. The Government sanctioned the demarcation of these, according to the survey of 1845, at a cost of R980, in its letter No. 1273T.R., dated 14th October 1893, to the Board; and the notification No. 4329 L.R. under the Survey Act appeared in the *Calcutta Gazette* of the 16th October 1893.

464. The survey and demarcation was therefore carried out during the past season, under the orders of Captain G. B. Hodgson. The surveyor, Irfan Ali, could only find three points identical with the survey of 1845 in the boundary of the *mahal* itself; it was therefore decided to include in the survey the adjoining village of Tilkup, which, being situated in well cultivated open country, had well defined boundaries, and which furnished sound initial points easily identifiable, on which to hinge the old boundary, for comparison with the boundaries of the *zamindár's* possession and those now claimed by Government.

465. In the first place the *zamindár's* possession as pointed out was surveyed, and its limits were found to bear a close approximation to the boundary of 1845. With the exception of a few flags on trees, no demarcation was found, and no Government representative was present.

Next, by the aid of common points the old boundary of the 1845 maps, having been carefully transferred to the new maps, was demarcated on the ground, rough oblong stones 3 to 4 feet in length, procured locally, being embedded at every bend. The offsets to these, from the new survey lines, have been recorded in field books.

When the work had been completed so far, the Collector requested that the Government claim should be demarcated; this was then done, and it detained the surveyor a month longer.

466. The combination of the old and new maps, the plotting and computations, were carried out under Captain Hodgson's own supervision.

Captain Hodgson reports that a Court *amin* had demarcated the *mahal* boundary (presumably from the old survey) some years ago, with the result that it was far from correct.

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467. The whole of the operations reported on above were under the direct supervision of Captain G. B. Hodgson; and Colonel Sandeman states that that

officer's labours, over which he has never spared any pains, have been very arduous, and that his acknowledgments are due to him.*

ASSAM.

No. 6 Party.

468. This party left recess quarters at Shillong on the 1st November 1893 under the charge of Mr. Gibson, and arrived in Sylhet on the 5th November. Mr. Gibson was relieved on his arrival in Sylhet by Mr. Barrett, who was re-appointed to the charge of the party on his return from furlough, and Mr. Gibson was then transferred to another party. Field operations were commenced in Cachar on the 15th November 1893 and continued until the 16th May 1894, when the party returned to recess quarters. The strength of the party is given in the margin. The cadastral establishment has again been largely reduced in consequence of the small area allotted for survey.

Personel.

Mr. E. C. Barrett, Superintendent, 2nd grade, in charge from 5th November 1893.
Mr. A. J. Gibson, Extra Assistant Superintendent, 1st grade, in charge up to 5th November 1893.
Mr. W. H. Penrose, Extra Assistant Superintendent, 6th grade.
Mr. J. Smith, Sub-Assistant Superintendent, 2nd grade, up to 15th May 1894.
17 sub-surveyors, draftsmen, computers, etc.

Temporary Establishment.

29 supervisors, inspectors, draftsmen, computers, etc.
18 field surveyors (imported).
62 ditto (local).

469. Intimation that the cadastral survey of the Cachar district was to be undertaken by the party was received by the officer in charge in September 1893. The area to be brought under survey was estimated to be between 1,000 and 1,200 square miles, about one-half of which comprises lands under grants. As the existing settlement does not expire until the 31st March 1898, there was no urgency for the speedy completion of the survey. It was therefore arranged that survey operations should extend over four seasons, or up to the close of the year 1896-97, and the programme for the season under review, which consisted of the traverse of 400 square miles and the cadastral survey of 150 square miles, was framed with that end in view and was adhered to. The completion of the work a year earlier has, however, since been resolved on, so as to allow sufficient time for the completion of all papers connected with the new settlement before the existing settlement expires.

470. A survey class for the instruction of officers of the administration and local men was opened at Badarpur early in December under Mr. Smith and was continued until the end of February 1894. The following officers passed in field surveying:—Messrs. Kershaw, Reid, Allen, Hamilton and Balthazar, Assistant Commissioners, five Sub-Deputy Collectors, two *tahsildars* and eleven *moharrirs*. In addition to these, 110 local men joined the class, 20 of whom were given employment as field surveyors, 70 received certificates of proficiency, and 20 failed to qualify.

471. The traverse operations were carried out in the Sadar sub-division, and the out-turn of traverse survey done during the season is given in the following table:—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Cachar	364	254	11,746	360

* Captain Hodgson reports as follows regarding the services of his assistants:—

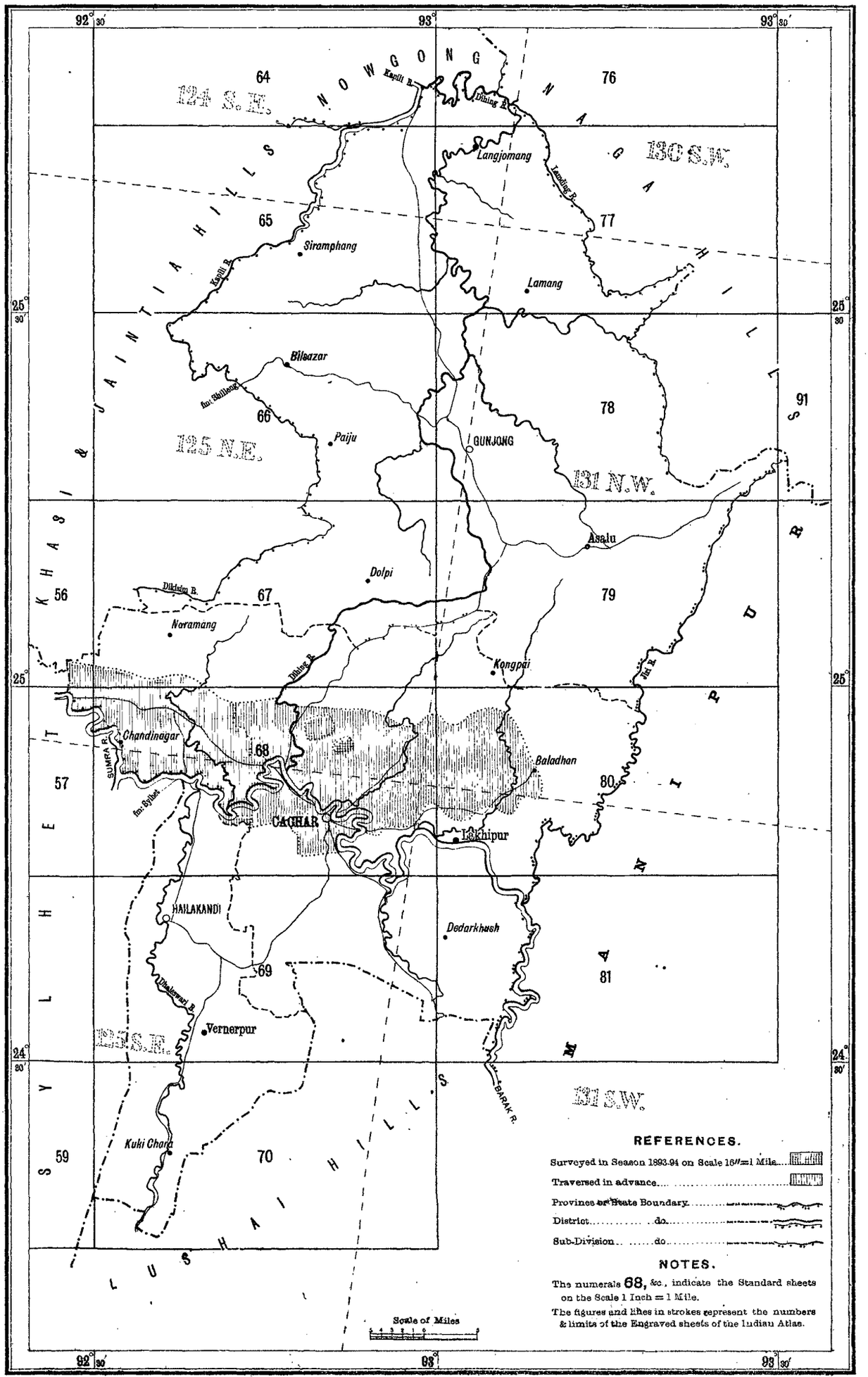
"The European assistants have one and all worked excellently.

"I commend the three camp officers for the manner in which they have brought up the work of their sections and have left practically no arrears."

Among the permanent native establishment the following have been especially selected by Captain Hodgson for mention:—Bhawani Pershad, Abdul Majid, Peari Lal, and Issar Chander Dey, and among the temporary hands—Raj Bahadur Shew Dial, Abdul Majid Khan, and Mahammad Ali, Inspectors.

ASSAM SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DIST. CACHAR** No. 6 PARTY.



REFERENCES.

Surveyed in Season 1893-94 on Scale 16″=1 Mile.

Traversed in advance.

Province or State Boundary.

District ..... do.

Sub-Division ..... do.

NOTES.

The numerals **68**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Reg. No. 482, S. I. D.—Feb. 95.—550.

Photo., S. I. O., Calcutta.

No. 341-S. 95.

The aggregate length of the traverse lines was 1,262 linear miles. Two stations of the Great Trigonometrical Survey were connected with the traverse to check the chain measurements thereof, and the angular work was checked by observations for azimuths taken at 62 stations.

472. Stone prisms, 3 feet long, were embedded at 130 village tri-junctions, while 349 old prisms, which were found *in situ*, were connected with the traverses. The boughs of the *Simal* or other quick-growing trees, surrounded with earthen mounds, protected by bamboo fencing, were planted 5 feet to the north of all traverse stations other than tri-junctions; but as it has been found that these marks are apt to disappear, chiefly from floods, it is intended during the coming cold weather to place blocks of undressed stone at such of the intermediate stations as require it, and in future theodolite stations will be marked with stone only.

473. The cadastral survey on the 16-inch scale was extended over the whole of the Katigorah *tahsil*, and a few grants of the Sadar *tahsil* were also surveyed. Particulars of the out-turn of cadastral survey are given in the following statement:—

District.	Tahsil.	Number of villages.	Number of fields.	Area in square miles.
Cachar	Katigorah	153	69,032	144·6
	Sadar	6	689	5·9
Totals		159	69,721	1·505

474. The area surveyed contains a considerable proportion of forests, but owing to the keenness of competition for land between the *rayats* and planters almost the entire forest area has been parcelled out into holdings.

475. The field to field survey was carried out, for the first time, in Assam, exclusively by local and Bengali field surveyors, supervised by Bengali inspectors. The surveyors worked carefully and well, but the Bengali inspectors proved to be lax in their duties, and on the whole did not answer expectations: it will be necessary to revert to employing Hindustanis as inspectors in future. Bengali-writing *amins* will, however, continue to be exclusively employed in the field to field survey. The grants were surveyed by sub-surveyors and picked Hindustani *amins*, as the work therein required topographical skill.

476. The average daily out-turn of work performed by each of the different agencies employed in the field survey was as follows:—

	Acres.
Bengali field surveyors	13·18
Local ditto (old)	13·25
Ditto ditto (new)	9·42
Survey class pupils	9·08

477. The average size of the field calculated on the total area surveyed is 1·38 acre, and the mapping of the season's out-turn is contained in 217 sheets. Two tracings of each map were prepared for the use of the Settlement Officer.

478. The detail work was tested by 388 linear miles of check survey, of which 48 miles were run by European assistants and 340 miles by native agency. Of the latter amount, 106 linear miles were run independently of the field sheets and compared afterwards in the office. The entries of 10,659 fields in the village registers were checked on the ground by the European assistants and by inspectors. The entries were also tested from time to time as the work progressed by the Sub-Deputy Collectors and *munsarims* of the Settlement Department.

479. The revision survey of the 484 square miles of the Jaintiah *parganas* in Sylhet, surveyed in season 1892-93, was completed: the work proved to be a much more arduous undertaking than had been anticipated. Revision operations were started on the 20th November 1893 with 23 *amins*, and the number was gradually increased till a maximum of 44 *amins* was reached. Work continued

in the field till the 10th May 1894. The number of objections inquired into exceeded 23,000, most of them of a frivolous nature, it is true, but they took up much time and unduly delayed the completion of the work.

480. The cost-rate of the survey operations, including traverse, detail survey, mapping, and completion of records amounted to R183·9 per square mile. The high rate is in a measure owing to the heavy expenditure on the traverse survey of the grants, the boundaries of which usually run through jungle or over hilly country, but it is chiefly due to the detail survey having been restricted to the small area of 150 square miles.

481. The programme for season 1894-95 comprises the completion of the traverse and cadastral survey of an area of about 500 square miles in the Sadar and Hailakandi sub-divisions, which will leave about 450 square miles for completion in the following year.

482. Mr. Barrett expresses his indebtedness to the Deputy Commissioner and other district officials for the assistance rendered by them during the progress of the survey.*

MERGUI, AMHERST AND SHWEGYIN DISTRICTS, LOWER BURMA.

No. 7 Party.

483. This party was employed during the season in the Mergui, Amherst, and Shwegyin districts, and it is satisfactory to report that the operations, (including the large scale surveys of the Maliwun tin-mines) in the first named district have now been completed. Owing, however, to the additional areas in Amherst assigned for survey being larger than was expected, and scattered over localities widely separated from each other and somewhat difficult to get about in, there still remain some 550 square miles of detail survey (with 300 square miles of traverse) for completion in that district during the coming season. Of the portion thus left over, perhaps 80 or 100 square miles might have been disposed of in the year under report, but for the delay in bringing to a close the Mergui work, and for the inclement weather which practically set at defiance all progress after the 24th April.

Personnel.

Mr. C. Wood, Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. H. R. Littlewood, Assistant Superintendent, 1st grade, up to 10th April 1894.
Mr. W. C. Price, Extra Assistant Superintendent, 3rd grade.
Mr. G. W. Jarbo, Extra Assistant Superintendent, 5th grade.
Mr. C. F. W. Seyers, Extra Assistant Superintendent, 6th grade, from 22nd April 1894.
Mr. J. Murphy, Extra Assistant Superintendent, 6th grade.
Mr. M. Gastaud, Sub-Assistant Superintendent, 1st grade.
Mr F. B. Powell, Sub-Assistant Superintendent, 2nd grade.
Mr. J. H. Murphy, Sub-Assistant Superintendent, 2nd grade, from 2nd May 1894.
Mr. M. F. Berkeley, Sub-Assistant Superintendent, 3rd grade.
Babu Amar Sing, Probationary Sub-Assistant Superintendent, 3rd grade.
25 sub-surveyors and others.

Temporary Establishment.

66 inspectors, draftsmen, computers, etc., etc.
87 field surveyors.

484. The conduct of the Mergui work was entrusted to Mr. Jarbo; that of Amherst being divided between Messrs. Littlewood and Price, the former operating generally between Amherst and Ye, and the latter in the Salween-Hlaingbwè township. The topographical survey of the hills falling within the cadastral area, or in proximity thereto, was entrusted to Mr. Gastaud. On his return from Mergui, Mr. Jarbo was directed to survey the Dutiyakayin gardens, maps of which the Settlement Department were anxious to obtain, if possible, before May; but although the survey was with difficulty completed, the results could not be supplied before the end of July. There were practically no revisions required by the Settlement Department.

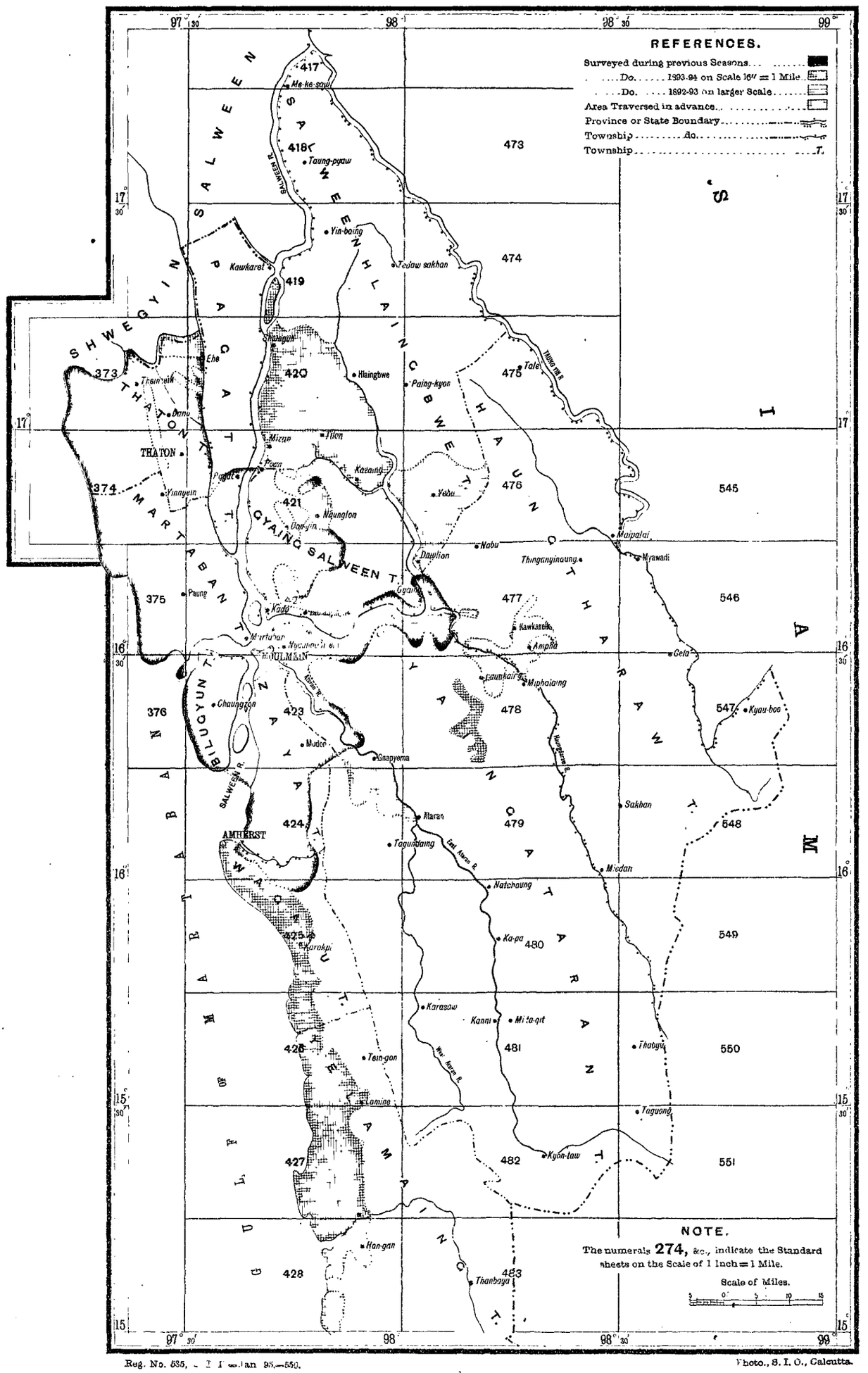
485. The squads for Mergui left Rangoon on the 4th November 1893. The Amherst traverse and topographical squads also left on the same date; and in order to give the boundary work a chance of getting sufficiently ahead (there being nothing prepared in advance in the additional areas allotted), the detail surveyors were called a fortnight later than usual, *i.e.*, on 15th December, and even then

*Mr. Barrett reports highly of Mr. W. H. Penrose, who held charge of the cadastral section throughout the year. Mr Smith is also said to have given satisfaction. Of the natives the following have been specially mentioned:—Sakhawat Hosain, Khurshed Hosain, Janardhan Rao, Krishnaji, Gholam Hyder, Fatteh Mohamed, Jhuni Lal, Bahadur Singh, Srikisto and Kedarnath.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT AMHERST.

1893-94. No. 7 PARTY.



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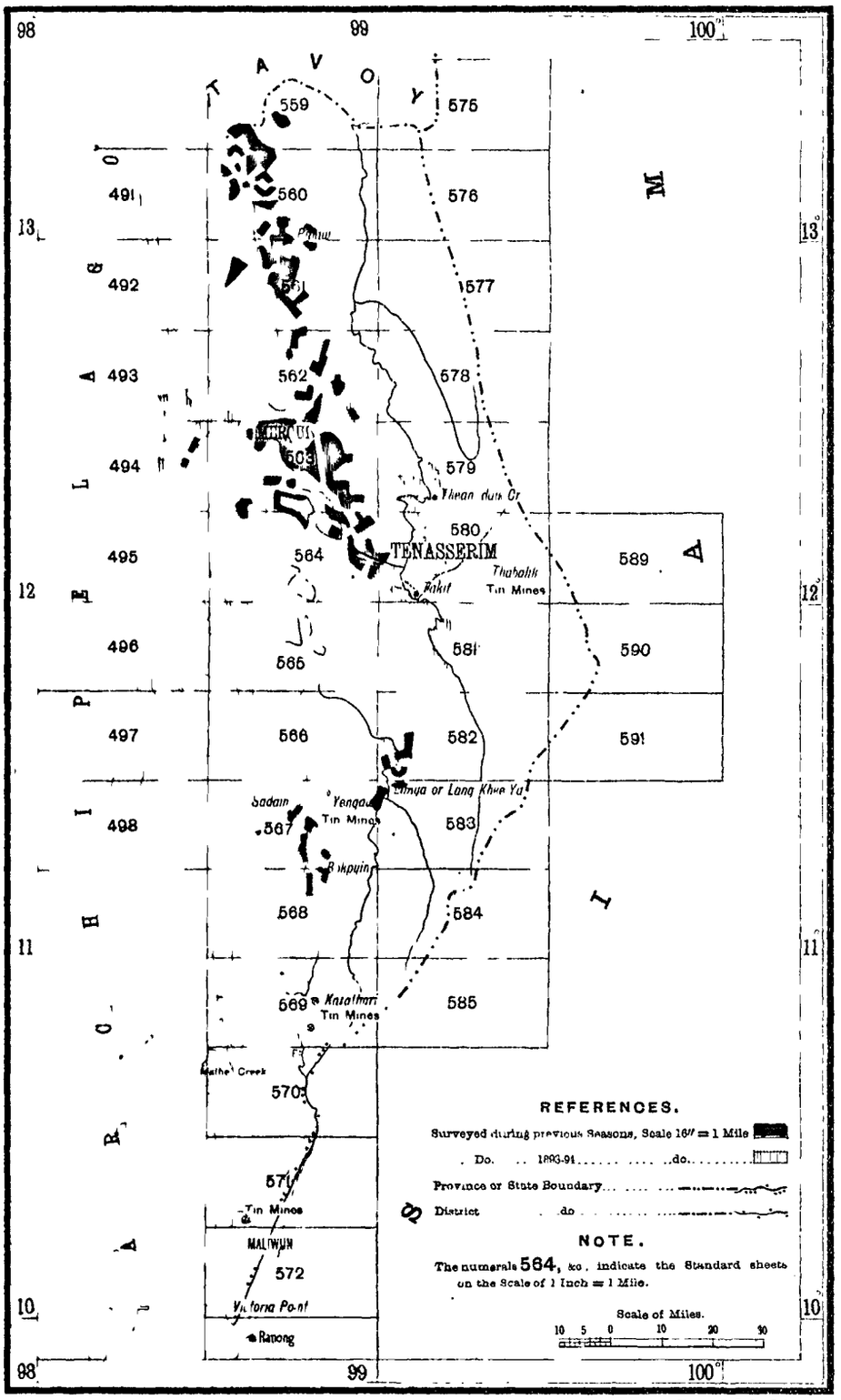
BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MERGUI.

1893-94. No. 7 PARTY.



REFERENCES.

Surveyed during previous Seasons, Scale 16" = 1 Mile

Do. .. 1893-94 ..... do.

Province or State Boundary

District do

NOTE.

The numerals 564, &c. indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Photo., S. I. O., Calcutta.

No. 321-S. 95.

two squads had to be found work in the Bilin and Kinywa circles of the Shwegyin district (in which 180 square miles of advance work had been done in 1892-93, as mentioned in paragraph 386 of the last Annual Report) till they could with advantage be placed on their ground between Amherst and Ye. The entire party returned to recess quarters at Rangoon between the 26th and 31st May 1894.

486. The work of the season comprised the following operations:—

In the Mergui district, (i) the survey, on the scale of 64 inches=1 mile, of 28 tin-mines in Maliwun and Bahuni, giving to each miner an extension of land area equal in area to that of his existing claim; (ii) the traverse survey of 106 square miles, and the detail survey on the 16-inch scale of 123 square miles, chiefly in the Payingyun (King's Island), Tamokchon, Banlaw, and Maliwun circles. The traverse survey of the tin-mines, though covering an area of only 1½ square miles in all, proved a longer and a more troublesome job than was expected, which was due chiefly to the difficulty in deciding what constituted a miner's 'existing claim' and the consequent want of demarcation.

In the Amherst district, (i) the traverse survey of 962 square miles, and the cadastral survey of 679 square miles, chiefly in the Wagaru, Yelamaing, Gyaing-Ataran, Haungtharaw, Gyaing-Salween, and Salween-Hlaingbwè townships; (ii) the topographical survey, on the 2-inch and 1-inch to the mile scales, of 221 square miles of intervening non-culturable tracts to complete gaps in the maps.

In the Shwegyin district, the cadastral survey of 79 square miles in the Bilin and Kinywa circles.

487. The demarcation of the *kwins* in Amherst was found to be much better than in former years; the only exception being that when demarcating the very large *kwins* in the Salween-Hlaingbwè township, the Settlement Department omitted to sub-divide them,—an omission which, coming to light when the traverse work, as well as some of the detail work, had been finished, was the cause of some delay and extra labour, as the survey party had to make the sub-divisions, which involved sending back traverse surveyors and the alteration of the calculations. In Mergui, little or no progress had been made with the demarcation of the tin-mines when Mr. Jarbo reached his ground, and on hearing from him of the state of affairs, the Executive Officer interviewed the Director and Financial Commissioner, and the latter at once issued stringent orders which led to the demarcation being taken in hand vigorously.

488. Owing to the difficulty of transport, galvanised iron cylinders were again substituted in certain localities for the heavier and more fragile pottery ones: the stations permanently marked were handed over, as usual, to the *thugyis* and *ywa thugyis*. Out of 23,408 stations in Amherst at which the theodolite was set up, 12,700 have been permanently marked, about an equal number of each of the two kinds of cylinders, *i.e.*, pottery and galvanized iron, having been embedded.

489. The following statement shows the out-turn of the season's work:—

District.	Traverse survey.		Cadastral survey, 16 inches=1 mile.				Tin-mines survey.	Topographical survey.	
	Number of *kwins*.	Area in square miles.	Number of *kwins*.	Number of fields.	Area in square miles.		Area in square miles.	Area in square miles.	
					Cultivation.	Jungle.	Scale 64 inches = 1 mile.	Scale 2 inches = 1 mile.	Scale 1 inch = 1 mile.
Mergui	84	108	131	31,462	31	92	½	...	...
Amherst	456	962	387	295,835	139	549	...	90	151
Shwegyin	...	...	67	38,638	40	39	...	...	...
Totals	540	1,070	585	365,935	201	680	½	70	151

490. The detail survey on the 1 and 2-inch scales was tested where practicable by *in sitû* fixings, and found to be very accurate; that on the 16-inch scale

was tested by 1,569 linear miles of chain measurements, of which 711 were done partly independently after the sheets had been received in office, and partly by the European assistants.

491. The cost-rates of the traverse survey in Mergui and Amherst were ₹177 and ₹61 per square mile respectively. The reasons for the high rate in the Mergui district are:—(i) The amount of the steamer charges for conveying the men from Amherst to Mergui and back, distributed as it was over a small area only. (ii) The high charges made by the Burmans for the hire of their boats which form almost the only means of communication in the country. (iii) The time lost in travelling to and fro. (iv) The long lines to connect the separate patches of cultivation which had to be run through dense jungle, which added to the labour without increasing the area. (v) The necessity of increasing the strength of each traverse squad to enable it to cope with the work.

492. It will be seen that this year the proportion of cultivation to jungle is very much less than before, being in Mergui as 1 to 3, and in Amherst-cum-Shwegyin as 1 to 4 nearly; while the average size of field, reckoned on cultivation only, is in the former 0·58 and in the latter 0·41 of an acre. Reckoning therefore for Mergui, as hitherto, that the cost of surveying 4 square miles of jungle is equal to that of 1 square mile of cultivation, and taking for Amherst this year—with such a preponderance of jungle stretching over large tracts—the cost of surveying cultivation at three times that for the same area of jungle, the cost per square mile of 16-inch work for Mergui is ₹224, and for Amherst-cum-Shwegyin ₹268; the former rate is about 9 per cent. less than the cost-rate of 1892-93, while the latter is 4 per cent. greater. The actual cost-rates per square mile of the above operations, *viz.*, traverse, detail survey with completion of maps and charges for instruments, are, for Mergui ₹275-7, and for Amherst ₹187-7. The cost of the topographical work on the 1-inch and 2-inch scales is ₹6,589, which gives a rate of ₹29·8 per square mile of survey.

493. The number of Burmans and Karens employed this year was thirty-six, *viz.*, 8 certificated men, 9 who have now put in five years' service and are entitled to a certificate, 6 men with four years' service, 9 out of the 15 men who had joined the party during 1892-93 though not coming under the Bridges scheme, and 4 altogether new men. With three exceptions among those last named, the work of these men was satisfactory: their average out-turn was a little larger even than in the previous year, being six-sevenths of that of the Hindustani. The average monthly earnings, however, were only ₹31-6, as against ₹32-11 of the year before, which is attributable to the long range between the localities in which the work lay, and to the greater preponderance of jungle in the season's operations.

494. In accordance with the wishes of the Burma Government, Mr. W. Carr, C.S., was attached to the party for six weeks in March and April for instruction in surveying: he was accordingly taught the use of surveying instruments as well as the setting up, calculation and proving of boundary surveys; he was also shown how to measure the areas of fields, etc., with the acre-comb and planimeter.

495. The results of portions of the work of the year in Shwegyin and of 1892-93 in Thaton were specially applied for by, and supplied to, the Executive Engineer, Martaban Division, to aid him in laying out portions of the line for a continuous water-way communication between Kyaikto and Moulmein and for some land reclamation projects. The Executive Officer also, at the invitation of the Local Government, assisted the Director in the half-yearly examinations in surveying held in November 1893 and June 1894 for members of the Land Records Department.

496. During the recess, 418 maps of the Mergui district for 1892-93-94, and 807 of Amherst, chiefly of 1892-93, have been examined and sent to Calcutta for publication; and between the 1st October and 1st December 1893, 755 maps of these districts were despatched: thus in the year under report no fewer than 1,980 sheets have been submitted. The drawing of the 2-inch topographical sections of the Amherst survey has made good progress, and three standard sheets have been sent in for publication, while several others are in a very advanced stage. The usual 16-inch tracings of *kwin* maps, area statements, 2-inch maps of the country cadastrally surveyed during the year, as well as a $\frac{1}{4}$-inch index map of *kwins* and circles, have nearly all been supplied both for Mergui

BURMA SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT SHWEGYIN.** No. 7 PARTY.

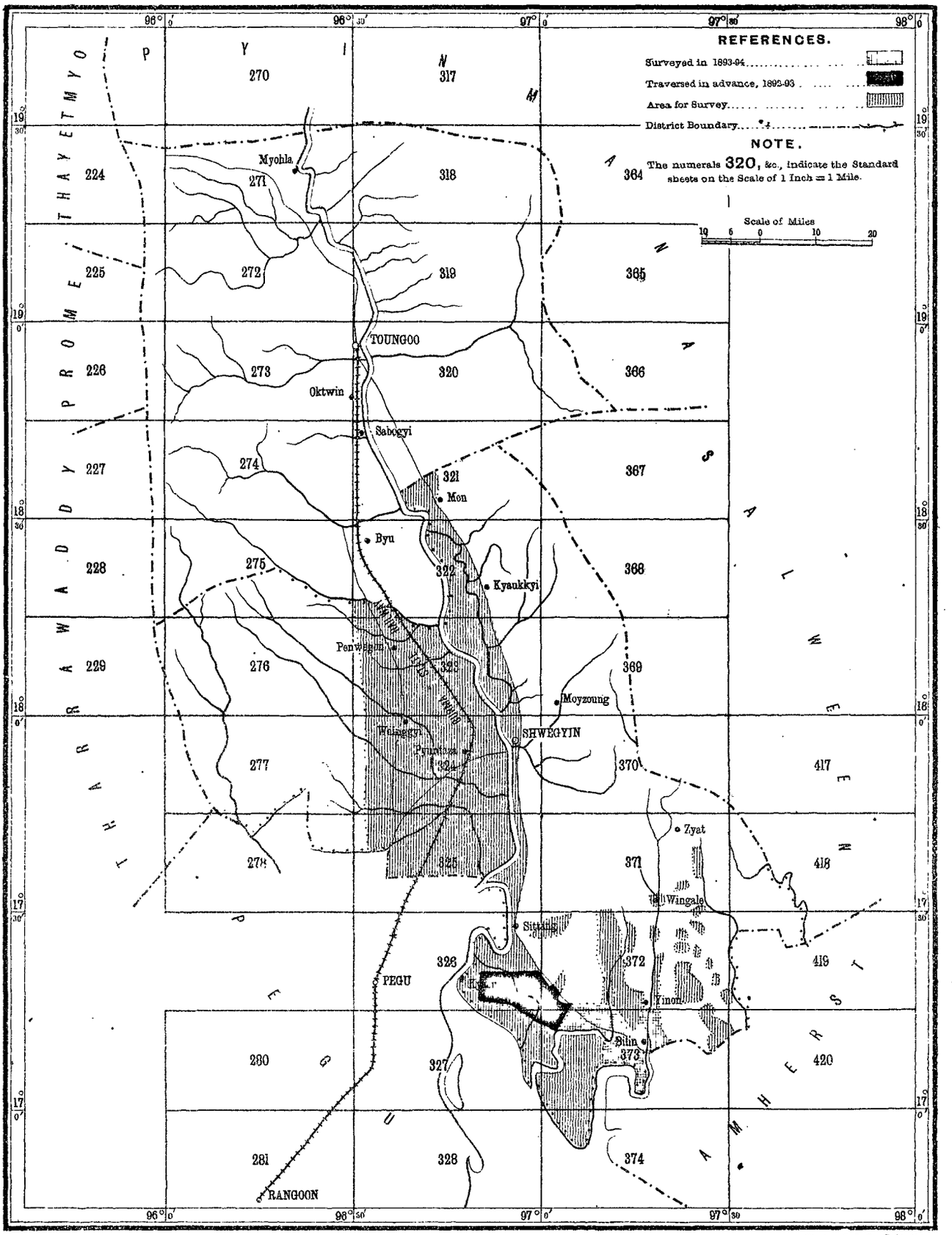


Photo., S. I. O., Calcutta.

No. 334-S. 95.

and Amherst; and those that remain will be in the hands of the Settlement Department by 15th October.

497. The bringing up to date of the preliminary sheets of the Rangoon Town district (referred to in paragraph 396 of the last Annual Report) has been continued this year, so that practically 13 out of the 19 sheets are done; the remainder for the most part include land, which, during the recess portion of the survey year is more or less flooded and must therefore be taken up during the dry months; these sheets will be completed by men deputed during the field season, and it is hoped that the maps will be all finished early next recess. The verification survey of certain town lots on the 50-feet scale was called for by the Financial Commissioner, and those required, *viz.*, 24 blocks, chiefly 800×860 feet, were surveyed and the results supplied to and paid for by the town-lands reclamation fund.

498. The binding and indexing of the volumes relating to the Mergui, Tavoy, and Amherst work have been practically brought up to date; and several of these will be deposited in Calcutta before the party takes the field.

499. The party was inspected by the Deputy Surveyor-General in the field in March 1894. Both camps, *i.e.*, the one at Amherst and that at Paan on the Salween, were visited in turn and the work examined in detail. At the latter camp the sub-division of the very large *kwins* in some parts of the Salween-Hlaingbwè township, which had only then been called for by the Director of Land Records and Agriculture, was arranged for. The field work and the general state of the records was found to be in a very satisfactory condition.

500. During the ensuing year, the party contemplates the completion of all the area allotted for survey in the Amherst district, and in surveying in detail about 400 square miles in the southern circles of the Shwegyin district, including the difficult garden lands in the Bilin and Yinon circles.*

MAGWE AND MYINGYAN DISTRICTS, UPPER BURMA.

No. 12 Party.

501. The party, under the charge of Mr. Spring, left recess quarters at Mandalay on the 8th November 1893, and commenced operations in the Magwe district between the 20th and 25th idem. Field work was continued until the end of May 1894, and the recess office was opened at Mandalay early in June. One traverse camp, however, recessed at Pagan, in the Myingyan district. The strength of the party is given in the margin; it was divided into two traverse camps under Messrs. Buttress and Little, respectively, and one cadastral camp under Mr. Swiney.

Personnel.

Mr. A. E. Spring, Assistant Superintendent, 1st grade, in charge to 19th April 1894.
Mr. H. R. Littlewood, Assistant Superintendent, 1st grade, in charge from 20th April to 9th August 1894.
Mr. W. S. Buttress, Extra Assistant Superintendent, 2nd grade, in charge from 10th August 1894.
Mr. E. G. Little, Extra Assistant Superintendent, 3rd grade.
Mr. J. S. Swiney, Extra Assistant Superintendent, 5th grade.
Mr. A. George, Sub-Assistant Superintendent, 1st grade.
Mr. W. E. Johnson, Sub-Assistant Superintendent, 2nd grade.
Mr. F. S. Bell, Sub-Assistant Superintendent, 2nd grade
Mr. H. W. Biggie, Sub-Assistant Superintendent, 3rd grade.
24 sub-surveyors and others.

Temporary Establishment.

25 inspectors, draftmen, and computers.
92 field surveyors (Indian).
40 field surveyors (Burman).

502. The programme originally arranged for the field season consisted of:—

(*a*) The traverse survey of about 1,200 square miles, and the cadastral survey of 1,000 square miles, in the Magwe district.

(*b*) Advance traverse survey in the Myingyan district.

(*c*) The traverse and cadastral survey of certain islands in the Irrawaddy river, situated in the Pakokku district, which was afterwards added to the programme.

Considerably more than this, however, was accomplished.

* The executive officer speaks very favourably of the work of his senior assistants, Messrs. Littlewood Price, Jarbo, and Murphy, making special mention of that of Mr. Jarbo in Mergui. The juniors, Messrs Gastaud, Powell, Berkeley, and Amar Sing are also favourably reported on. Of the permanent native establishment the following are commended:—C. Abreu, Hidayatulla, Faiz Buksh, Mahomed Umar, Mahbub Ali, Bisesardyal, Maung Hpo Kyone, Maung Hpo Kah, and Ori Pande.

503. The demarcation of village boundaries in the Magwe district was well in advance of the survey and had been well carried out, but in the Myingyan district the traverse surveyors quickly caught up the demarcation establishment, which had then to be augmented by two extra demarcation officers, appointed from the Survey department at the request of the Director of Land Records and Agriculture. After the establishment was thus increased there was ample work for all, and a larger area of cadastral survey could have been turned out had not the traverse survey in advance been stopped. This was done in consequence of the survey operations having got too far in advance of the settlement operations, which could not keep pace with them. The Local Government therefore desired that in future the annual out-turn of cadastral survey should be reduced. With the exception of four sub-surveyors, who were employed on revision surveys, the traverse establishment was discharged at the end of April 1894. These four sub-surveyors continued work till the 25th May, after which date three were discharged and one was retained during the recess to complete the revision work.

504. At the commencement of the field season, Mr. E. G. Little was deputed to go over the country in the Myingyan township, and to report whether it was suitable for 16-inch cadastral survey. From that officer's report it appeared, that though the country along the Irrawaddy river was much cut up by ravines, and the soil was very rocky, yet it was not of a sufficiently hilly nature to need a change of scale being made, and it was decided that all the villages should be surveyed on the 16-inch scale. The area in the Magwe township is also intersected by deep ravines, but still the portions not so broken contain cultivable lands, and in the other portions there is always a possibility of finding petroleum, which would render a 16-inch survey desirable. Yenangyaung, whence a considerable amount of petroleum is obtained, fell within the area of survey this season.

505. The out-turn of work done during the season, arranged by townships both as regards traverse and detail survey, is given in the following table:—

District.	Townships.	Traverse Survey.			Cadastral Survey, 16 inches = 1 mile.		
		Number of villages. (*kwins*)	Number of sub-traverses.	Area in square miles.	Number of villages. (*kwins*)	Number of fields.	Area in square miles.
Magwe	Myingun	328	342	435	328	1,18,977	425
	Mypthit	2	3	4	313	2,56,141	390
	Netmauk	798	737	761	356	98,798	355
	Magwe	319	228	389	18	12,084	80
	Totals	1,447	1,310	1,589	1,015	4,86,000	1,250
Myingyan	Sale	116	116	120	...	...	...
	Kyaukpadaung	79	59	80	...	...	...
	Totals	195	175	200	..	...	...
Pakokku	Islands	29	9	26	29	11,040	26
	Grand Totals.	1,671	1,494	1,815	1,044	4,97,040	1,276

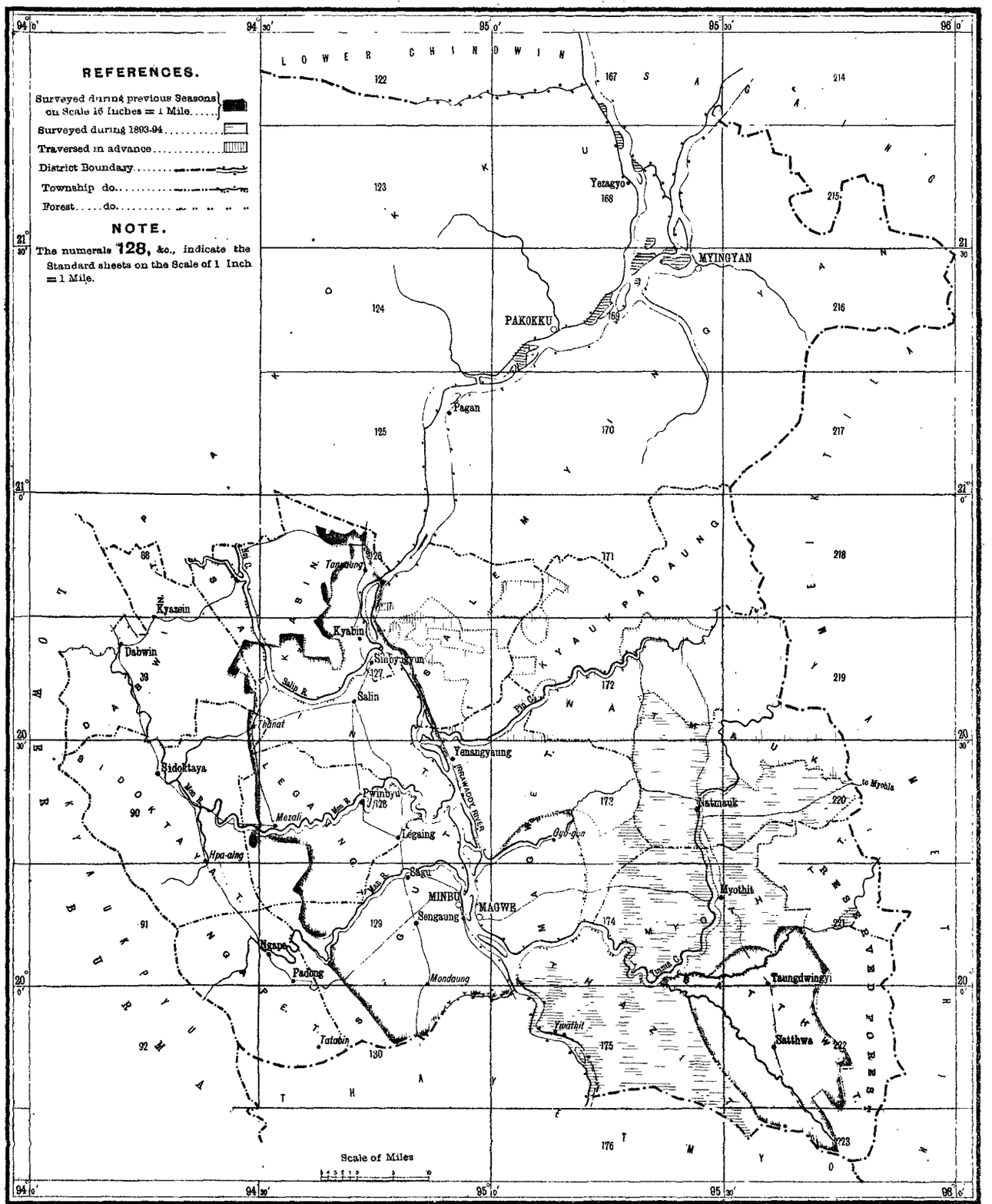
506. In the survey of the islands in the Irrawaddy, in the Pakokku district, as they are annually flooded, it was necessary to have stations so arranged on the main land that the positions of certain selected marks on the islands could always be recovered without the necessity of calling in a professional surveyor to fix them: this was done.

507. The average size of the *kwin*, or village, is 782·22 acres, and the average size of the field calculated on the whole area is 1·64 acre; but excluding uncultivated tracts, the average size of the field is about 0·29 of an acre in irrigated tracts and 1·04 acre in unirrigated tracts. Of the area surveyed about 496 square miles are cultivated and 780 square miles uncultivated. All the

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS MINBU & MAGWE.

1893-94. No. 12 PARTY.



Reg. No. 687, S. I. D.—Jan. 95,—550.

Photo., S. I. O., Calcutta.

No. 322-S. 95.

principal streams and cart roads in the uncultivated tracts were surveyed and mapped on the 16-inch sheets.

508. The traverse survey was connected with 11 trigonometrically fixed points of the topographical survey, and a comparison of the results shows an error of about 5 feet per mile in the traverse measurements. The angular work was checked by astronomical observations for azimuth, taken at intervals of about 30 stations. The origin of survey for the four districts, Minbu, Magwe, Myingyan and Pakokku, is the intersection of the parallel of latitude 21° with the meridian of 95°.

509. Scarcity of water and a sparse population were the chief obstacles to rapid progress; there were large tracts in which there was either bad or no water and no villages, and this made it necessary for the surveyors therein to go long distances to and from their work. In other parts, more especially along the banks of the Irrawaddy, the broken character of the country caused much delay.

510. Corrugated iron pipes were again used this season for the permanent marking of traverse stations. Many stations which were thus marked in the previous season were examined by the assistants, and found to be in good condition. There are 32,435 theodolite stations in the season's work, *viz.*, 28,285 in Magwe, 3,887 in Myingyan, and 263 in Pakokku, all of which were permanently marked. The average number of these permanent marks in a square mile is 18 in Magwe, 19 in Myingyan, and 10 in Pakokku. Plots of village boundaries on the 2-inch scale, showing the positions of all the stations, were prepared in duplicate on printed forms enjoining *thugyis* to preserve the marks, and these were submitted to the Deputy Commissioners for distribution to the *thugyis* to enable them to find the sites.

511. There were 40 Burman field surveyors employed on the cadastral survey this season, and 92 field surveyors from India. The average monthly earnings of the Burman was R31-3-6, and that of the Indian R42-13-6. The greatest amount earned during the season by a Burman surveyor was R273, and that by an Indian was R472. The work done by the Burmans is good, but the above figures clearly show that he is very much slower.

512. Local chainmen were again employed this season and no difficulty was experienced in getting men to serve. The Burman field surveyors worked entirely with local men, while each Hindustani surveyor had two Burmans attached to his squad. The total amount of wages paid to the local men was R11,500 at four annas per diem, which has therefore gone to the benefit of the poorer class of villagers, instead of being paid to men imported from India.

513. The field survey was tested by check lines run by inspectors during the progress of the work, and by the European assistants when the sheets were completed, as well as by independent check surveys carried out after the field maps were lodged in the office; the comparisons were generally found to be satisfactory, only a few sheets having to be re-surveyed. There were 277 linear miles run by assistants, 1,800 by inspectors, and 587 independently, making a total of 2,664 linear miles of test survey. The average amount of test work is 2·09 linear miles to each square mile of survey. The sub-surveyors, inspectors and field surveyors were periodically visited by the camp officers and the assistants as the work progressed.

514. The season's detail survey in district Magwe is mapped on 1,584 sheets. The drawing is well advanced and every hope is entertained of completing the mapping before the party takes the field. As a settlement officer for the Magwe district has not yet been appointed, the tracing and area statements of the 1,015 villages, comprising the area of 1,250 square miles, which was surveyed this season, will be kept in the office of the party. At the request of the Deputy Commissioner of Minbu, tracings of 83 villages, covering an area of 110 square miles in the irrigated tracts in the Sibingyaung township, were furnished: these were prepared by Burmans. The compilation of the topographical maps on the 2-inch scale for reduction by photography to the 1-inch scale is in progress, and by the close of the recess season the mapping of 7 sheets will be completed. The computations of the traverse surveys were all completed and the other records have been brought up to date as far as possible.

515. The cost-rates per square mile for the different classes of work are as follows:—Traverse survey, Rs. 44-10-9; permanent marks, R4-11-4; detail survey on the 16-inch scale, including the supply of area statements and tracings, R110-11-9. The aggregate cost-rate per acre for all these operations amounts to Ro-3-11 per acre, which is a decrease of about 9 pies per acre on the rate of last year; this includes the cost of the preparation of tracings and area statements for the settlement officer and the permanent marking of the traverse stations.

516. The establishment kept in good health on the whole during the field season; three deaths, however, occurred from fever, *viz.* one computer and two *khalásis*.

517. The Deputy Commissioners of Magwe and Myingyan, as well as the sub-divisional officers, rendered every assistance to the Survey Department during the past year. The villagers also were perfectly willing to help to the best of their ability and no complaints of any kind were made to the civil officers about the men of the Survey Department.

518. As the survey operations have got too far in advance of the settlement operations, it has been decided by the Local Government that smaller areas are to be surveyed annually in future. The programme arranged for the ensuing field season is therefore as follows: An area of 1,000 square miles of advance traverse work in the Myingyan district, and the completion of the cadastral survey of the Magwe district, comprising an area of about 900 square miles.

519. The Deputy Surveyor-General inspected the party during the field season in the beginning of April 1894, and was well pleased with all he saw. This was Mr. Spring's first season in charge of a party, and it is satisfactory to be able to report that the party has, under his superintendence, done a good season's out-turn at a reduced cost. Just before the end of the field season Mr. Spring was obliged to take sick leave. As soon as his services could be spared from No. 7 Party, Mr. Littlewood was ordered to take Mr. Spring's place, and he superintended the recess work of the party at Mandalay until August, when he died suddenly of cholera. Mr. Littlewood entered the department in the junior division in 1860, and was promoted into the senior division in 1891. His whole service was spent in the Revenue Branch, in which he has rendered excellent service, more particularly with reference to cadastral surveys in Lower Burma, where he worked for the last nine years of his service. After Mr. Littlewood's death Mr. Buttress took temporary charge and superintended the completion of recess work.*

GARHWAL DISTRICT, NORTH-WESTERN PROVINCES.

DETACHMENT.

520. The strength of the establishment, which continued the cadastral survey in Garhwal, was as marginally noted. Only 33 of the previous season's staff of field surveyors from the plains returned to work in October 1893, as the privations they had had to submit to, owing to the failure of the winter crops for two seasons successively, and the unusually severe winter experienced last year, induced them to seek employment elsewhere. No disadvantages resulted therefrom, as the area left for survey contained a much smaller proportion of cultivation, and the local field surveyors soon got through the work. Their out-turn this season averaged that of the more experienced plains men, and the quality was as good.

Personnel.

Mr. T. F. Freeman, Extra Assistant Superintendent, 5th grade, in charge.
Mr. W. Skilling, Sub-Assistant Superintendent, 2nd grade.
Mr. J. H. Murphy, Sub-Assistant Superintendent, 2nd grade, up to 1st April 1894.
7 sub-surveyors, computers, etc.

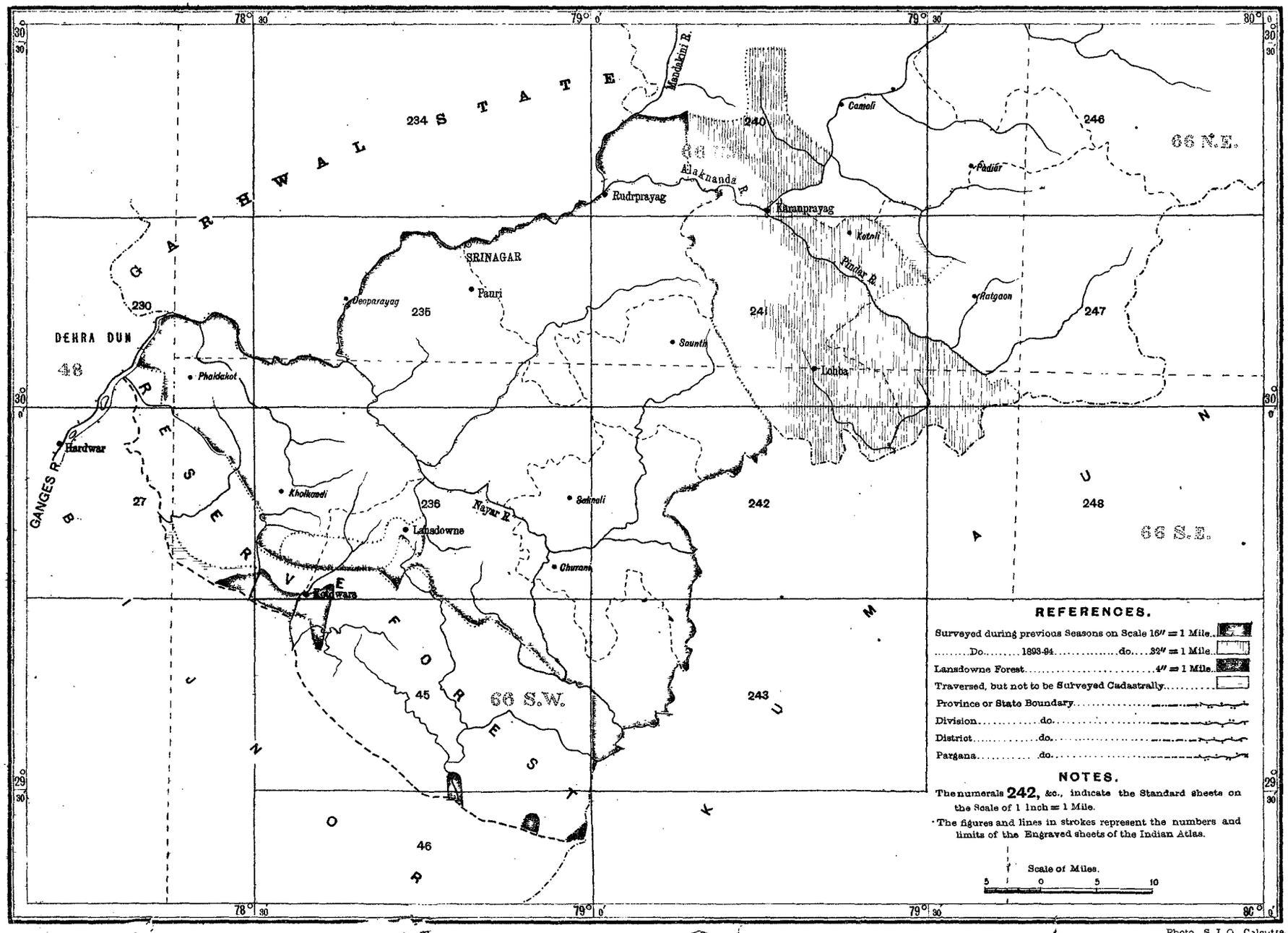
Temporary Establishment.

14 inspectors.
33 field surveyors (Hindustanis).
147 ditto (Local).
191 draftsmen, estimators and *muharrirs*.

* The European assistants have all done good work, but Mr. Littlewood left on record that he desired that especial mention should be made of the services and capabilities of Mr. J. S. Swiney. The members of the Native establishment have, on the whole, worked satisfactorily, and the following men are brought to notice: Hera Lall, writer, Moti Lall, Golam Hyder, Abdul Wahid, Tufail Ahmed, Makbool Hosein, Enayetullah, Nathra Khan, Mahomed Ali and Ram Narain.

N. W. PROVINCES SURVEY.

1893-94. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT GARHWAL.** GARHWAL DETACHMENT.



REFERENCES.

Surveyed during previous Seasons on Scale 16″ = 1 Mile.	
.....Do.....1893-94.....do.....32″ = 1 Mile.	
Lansdowne Forest.....4″ = 1 Mile.	
Traversed, but not to be Surveyed Cadastrally.....	
Province or State Boundary.....	
Division.....do.....	
District.....do.....	
Pargana.....do.....	

NOTES.

The numerals **242**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

5 0 5 10

Reg. No. 510, S. I. P.—Cp. 95.—350.

Photo., S. I. O., Calcutta.

No. 342-S. 95.

521. Field work was resumed on the 25th October 1893, and continued till the 7th April 1894, when the entire field work required to be done was completed. Operations were at first confined to the completion and final checking of villages partially surveyed last season, and were then continued in the remaining *pattis* sanctioned for survey under G. O. No. $\frac{405}{46}$, dated 22nd February 1893. The proportion of cultivated area in these *pattis* proved to be considerably below what was estimated by the local *patwáris*, who had allowed for a considerable increase in cultivation since last settlement, and it was calculated that field operations would be completed by the end of February 1894 if no other work were provided for the establishment. A recommendation was accordingly submitted that two out of three *pattis* which had already been traversed, but had been excluded from the area to be surveyed by professional agency, should be taken in hand, and thus work provided for the establishment for at least another month. Sanction was accorded to this and the area for survey was thus increased by 14·4 square miles.

522. Traverse operations were confined to revising those lines which had been run during seasons 1890-92, but had not proved satisfactorily, and to the running of supplementary traverses where the position of scattered cultivation could not be correctly fixed by intersections. Observations were taken at eighty-two stations, and the number of linear miles of chaining amounted to 13·1 miles. No additional connections were made with trigonometrical stations, as the supplementary traverses emanated from and closed on other traverses, which had been finally proved.

523. All theodolite stations have been permanently marked by cross-cuttings on rocks *in situ*, or by rough uncut stones embedded in the ground and covered over with mounds of loose stones and earth. Receipts have been taken from the *zamindárs* for the same throughout the district, and now, on the completion of the survey, they have been made over to the Deputy Commissioner of Garhwal for record in his office.

524. The cost of the season's traverse work amounts to ₹475. Of this amount ₹179 were spent on the supplementary traverses, whilst the balance of ₹296 was incurred on the revision work and the final completion of the records of the previous four seasons. The total expenditure incurred on the Garhwal traverse surveys amounts to ₹60,841-6-11, and the total area surveyed is 1,723 square miles, thus giving a rate of ₹35-4-11 per square mile for the district.

525. The cadastral survey, which was continued on the scale of 32 inches = 1 mile, embraces four of the better cultivated and more accessible *pattis* of *pargana* Badhan, one of Nagpur, the remaining *pattis* of *pargana* Chandpur, and the unreturned area surveyed last season, but not finally tested. The details of the season's out-turn are given in the following table:—

Parganas.	Cadastral Survey. 32 inches=1 mile.			
	Number of *pattis*.	Number of villages.	Number of fields.	Area in square miles.
Chandpur . . . . . . Badhan . . . . . . Nagpur	8	653	343,431	261·

Of the 261 square miles surveyed, 107 square miles are under cultivation, the remainder being occupied by village sites, roads, and strips of waste land intervening between the fields. The average size of the field is 0·49 of an acre.

526. The small block of 6·5 square miles in the Bhabar (called the Papidanda block), which was traversed in advance last year, was not surveyed cadastrally during the current season as had been intended. The land not having been brought under cultivation yet, the Settlement Officer requested that the detail survey might be postponed indefinitely. The skeleton traverse plots, consisting of eleven sections, have been made over to the Settlement Officer to enable the survey to be made, when necessary, by local agency.

527. The cost of the detail survey and record writing of the area surveyed this season in Garhwal amounts to ₹25,942, giving a rate of ₹99-6-4

per square mile, as compared with R173-12-0 per square mile during 1892-93. The total cost incurred during the season, including the preparation of the settlement records of 1,249 villages, 596 of which were surveyed in the previous season, and the final finishing of maps, area statements, etc., amounts to R47,222, which gives a rate of the R181 per square mile calculated on the current season's out-turn. Owing to the much more rapid progress made by the hill-men in office as well as in field work, all arrears and the general finishing of village maps and area statements have now been disposed of. The only work that remains to be done is the correction of maps and field areas from time to time, as correction slips are received from the Settlement Department after the verification of records and the disposal of all boundary disputes.

528. There were 135 boundary disputes in the current season's work in addition to the 194 cases undecided last year. The Deputy Collector who was deputed to decide these disputes, having other district work to attend to, could not devote much time to the disposal of these cases whilst survey operations were in progress; this has resulted in his having decided only 232 out of 329 disputes up to date. Until the remaining 97 are decided, the maps and area statements of 194 villages cannot be finally completed.

529. Every endeavour was made to show correctly all authorised partitions in fields so as to reduce the number of corrections in field boundaries which would appear at time of attestation. Small slabs of stones 6 to 9 inches in length, embedded in the ground, usually mark partitions in fields, but in many cases partitions sanctioned 6 to 7 years ago had not been given effect to as they were based on the old settlement maps and records which are quite obsolete. It was impossible to identify the old fields, and consequently partitions sanctioned several years ago had in some cases not even been attempted; and in others they were made at random which caused endless disputes and confusion at the time of writing the records. In one case in which a European planter was concerned, the interested parties had their respective shares in a village verified by order of the court on three different occasions and each time different fields were pointed out to them as theirs. The result was that when an attempt to write the records was made, each shareholder claimed rights to fields as it suited him, thereby preventing any progress in the work. Eventually the inspector was directed to compare the old settlement map with the fields on the ground, when it was found that the last verification of shares had been made by a *patwári* with the old settlement map of one village and the records of another. The incorrect and casual way in which this partitioning of fields had been carried out increased the work both of survey and settlement, and the alterations in field boundaries and numbers were very numerous; as an instance of its effect in some cases it is worth mentioning that in three villages the surveyor recorded 152, 481, and 937 fields, which were increased at time of attestation to 347, 618 and 1,207, respectively.

530. The procedure adopted last season in preparing the record of rights was strictly adhered to, though in many cases the villagers protested against waste land intervening between their fields, being recorded in the name of Government. In order to secure rights in such strips of waste, they frequently ploughed up the land at time of survey with the intention of utilising it afterwards for grazing purposes or extending their cultivation; this they cannot do now without the sanction of the district authorities. No alterations were made in the classification of soils as no differences existed in the classes of land in the *parganas* now surveyed. Attempts at concealing irrigated lands were made, but these were frustrated by inspections being made subsequent to the completion of the records of all villages where traces of old irrigation channels existed.

531. The standard of measurement used in Garhwal is the *nali*, which is equivalent to 240 square yards and is the area supposed to be covered by the amount of seed contained in a wooden cup measure which is called a *nali*. The *nali* is subdivided into sixteenths, each of which is called an *anna*, and 320 *annas* or 20 *nalis* equal one *bisi* or 4,800 square yards. The *bisi* is not recognised as a standard in any of the Government records; *nalis* and *annas* only being recorded in all settlement papers. In the present survey the area of each field has been recorded in acres, and also in *nalis* and *annas*, for convenience of comparison with old statistics.

532. The survey has been carefully checked on the ground by the European officers in the course of their inspections. The independent tests and check lines run by European assistants aggregate 295 linear miles and those by inspectors 254 linear miles. This gives an average of 2·1 linear miles of check lines in every square mile of survey. In 25 cases the work proved unsatisfactory and had to be redone; otherwise it was found to be good. Of the entries in the records, 20,974 numbers were tested by European officers, and 109,647 by the native inspectors, giving an average of 37 per cent. of fields checked. As a rule rights had been correctly recorded, and where disputes existed they were entered in the dispute list. The Deputy Collector employed on the attestation of the survey records admits that the entries recorded, even where disputes exist, generally prove correct, and better records could not be prepared than those submitted during the past year.

533. The field season closed on the 7th April when the entire office staff proceeded to Naini Tal, where there was sufficient accommodation for the whole of the reduced staff. The entire establishment working together at Naini Tal offered greater facilities for references between the different sections, thereby assisting in the completion of the settlement records earlier than was anticipated.

534. The season's out-turn of work in Garhwal is mapped on 1,115 sheets on the 32-inch scale. The names of villages, (with their settlement numbers), *pattis*, *parganas* and district, together with the scale and season of survey, have been printed on the maps in English as well as in the vernacular to render them more complete.

535. The records prepared for the Settlement Department are exactly the same as those given in last year's report. All the records of the current season's work and those of 596 villages surveyed last year were completed and made over to the Settlement Department by the end of July 1894.

536. The maps and area statements of all other villages except the 194 mentioned in para. 528 are finally complete, but until all the *parganas* are attested by the Settlement Department and the additions or alterations communicated to the survey, the records to be lodged in the Survey Office at Calcutta cannot be despatched. Up to the present time permission has been obtained from the Settlement Officer to despatch the records of *parganas* Barahsyun, Chaundkot and Malla Salan, though in these even there is a likelihood of some further alteration being ordered on the disposal of the final appeals which have been made.

537. The total area surveyed in the Garhwal district on the 32-inch scale amounts to 980 square miles. From this a deduction of 28 square miles has been allowed for terrace walls existing inside fields, thereby reducing the area recorded in the village *khasras* to 952 square miles, of which 512 are under cultivation or lying fallow; the rest is not culturable. The assessed area over the whole district at the last settlement was only 234 square miles, so that the assessable area as found to exist by the present survey has more than doubled. The total number of fields is 2,877,305, thus giving the average size of the field over the whole area surveyed as 0·21 of an acre. These figures exclude the area surveyed in the Garhwal-Bhabar on the 16-inch scale.

538. The cost per square mile in 1890-91, when operations first began, was ₹282 and that of this season's out-turn is ₹181 per square mile, including completion of all Settlement records. Particulars as to areas and cost-rates of the whole of the Garhwal cadastral survey will be found at page 108.

539. The geological surveyor, who had been deputed to report on the general safety of the hill sides, overlooking the Naini Tal lake, expressed his inability to offer an opinion without being provided with a correct contoured map of the station. No such map being available, the Local Government directed, under Public Works Department G. O. No. $\frac{3100}{3290}$, dated 21st May 1894, that a contour survey should be made of the basin of the lake, with as little delay as possible, and that the old map of Naini Tal should be corrected up to date by the insertion of all new buildings and roads. The field staff having been granted the usual departmental leave during the recess, it was necessary to recall a few surveyors for this purpose; they returned on the 2nd June, but great difficulty was then experienced in collecting a sufficient number of *khalásis* though a higher rate of pay than usual was offered. The setting in of the rains on the 10th June greatly retarded progress, as even when not raining the hill tops were constantly shrouded in mist and prevented observations being taken.

540. It was accordingly decided that an attempt should be made to complete this year the detail survey of those parts of the station in which additions or changes had been made since the last survey of 1872, whilst the contour survey, which was to be based on heights determined by triangulation, should be postponed till March next; when it is hoped clear weather and a sufficient staff of *khalásis* will admit of the work being completed in a couple of months. Up to the present time the detail survey of the parts of the station which had to be revised is completed; and 38 trigonometrical stations have been fixed in the area (about 2 square miles) requiring to be contoured. In addition to this, 53 points have been fixed by interpolation, and there are, now altogether 91 trigonometrically determined heights, which will afford sufficient data for a contour survey.

541. Owing to the completion of survey operations in the Garhwal district, the detachment is now being broken up and the members transferred. Mr. Freeman, who has held charge of the detachment since October 1891 will be transferred to the Provincial staff of the North-Western Provinces. He has had an unusually difficult task in Garhwal, and it is greatly to his credit that he has completed the survey so satisfactorily. At first, in addition to the severities of the hill climate, which prevented men from the plains readily joining his party, he had to combat the objections of the natives to a survey at all; besides this he had to provide his men with supplies from outside sources on account of local famines, but in spite of all difficulties he has carried on his work each year showing an increased out-turn until this last year, when he had only to complete what was left.

542. In the course of the survey, over 300 hill men have been trained and are now available for any other surveys which may be made in the Kumaon Division. Several men have already obtained employment in the Garhwal Settlement Department; and it is probable that others will shortly be engaged by the Forest Department and the Deputy Commissioner of Naini Tal.

543. The officer in charge expresses his indebtedness to Mr. W. R. Partridge, the Deputy Commissioner of Garhwal, and to the sub-divisional officers of the *parganas* surveyed, for their cordial support throughout the season. But for the assistance of the Deputy Commissioner, the difficulties in obtaining supplies for the establishment would have been much greater. Pandit Manik Lall Joshi, the sub-divisional officer of the northern *parganas*, endeavoured in every way possible to expedite the completion of the work by warning *zamindars* whilst he was on tour of the penalties they would incur should they fail to render general assistance to survey employés.*

ORISSA.

DETACHMENT.

544. This detachment, which continued the cadastral survey of the Orissa Division, comprised the remaining portion of No. 8 Party, after the transfer to Bihar of two cadastral sections as reported in paragraph 217. The charge of the detachment was held by Mr. R. C. D. Ewing throughout the year.

Personnel.

Mr. R. C. D. Ewing, Extra Assistant Superintendent, 5th grade, in charge.
Mr. E. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
Babu Nilmoni Chatterjee, Sub-Assistant Superintendent, 3rd grade.
1 sub-surveyor.
35 inspectors.
99 computers and draftsmen.
170 field surveyors.
208 *khanapuri amins.*

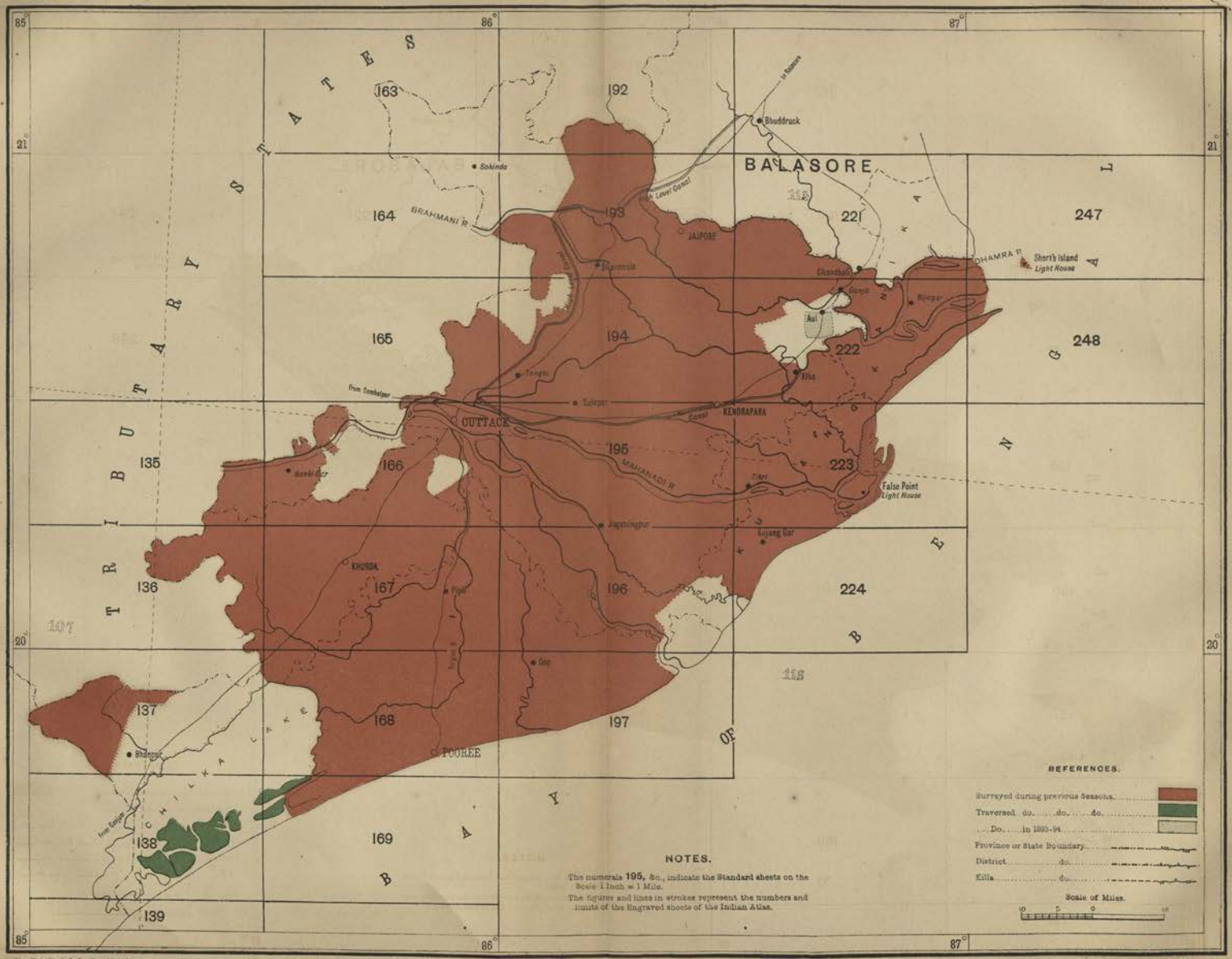
545. The following are the operations on which it was engaged:—

(1) The traverse survey of killa Aul in district Cuttack.
(2) Demarcation of the Sukinda-Dhenkanal boundary.
(3) Cadastral survey in district Balasore.
(4) Revision survey of the Jagannath temple lands, district Puri.
(5) Demarcation of the Orissa-Madras boundary.

* The officer in charge reports that the assistants, Messrs. Skilling and Murphy, have given general satisfaction, whilst amongst the native staff the following are deserving of mention:—
Badri Pershad, Hari Singh, Ali, Bishambar Sahai, Dilshad Ali, and Sayed Ullah.

ORISSA SURVEY.

1893-94. INDEX TO THE CADASTRAL SURVEY OF ORISSA, DISTRICTS CUTTACK & POOREE. No. 8 PART



Reg. No. 479, S. I. O.—Jan. 95—1,333

Photo., S. I. O., Calcutta

No. 310-S. 95.

Survey of the Cuttack District.

546. The cadastral survey and record-writing of the temporarily settled lands of the Cuttack district had been practically completed during season 1892-93. These operations were commenced in 1890-91 and cover an area of 2,269 square miles. In April 1894 orders were received to traverse the temporarily settled *mauzas* of killa Aul in that district, which it was ascertained comprised 148 villages. Of these, 16, or portions of them, are temporarily settled, and 2 or portions thereof are under irrigation; these will, therefore, come under cadastral survey, with a record of rights. The remainder are under permanent settlement.

547. Traverse work was commenced on 13th June, and the rains having set in early (10th June) very little was possible; but eventually 31 polygons, having an area of 15 square miles, were traversed. The angles measured number 370 and the aggregate length of chaining was 59 miles. The cost has been ₹798; the rate per square mile is ₹53·2.

548. No cadastral survey could be undertaken, for the *pargana*, being low-lying, was inundated in July.

549. The revision of the Cuttack town records was carried out. In November 1893 the tracings and records were completed and Mr. R. Nathan, C. S., was appointed to undertake final attestation. At his request, and with the concurrence of the Settlement Officer, the records and tracings which were prepared under the direction of the Collector of Cuttack, according to the 35 *sahis* into which the town is divided, were rejected and the entire work re-cast into 13 *mauzas*. Fresh tracings were prepared, the *khatians* re-written, and in the *khasras* numbers were changed: this was a laborious and delicate task, for a single mistake in the numbering would have entirely dislocated the remainder of the series. The re-casting commenced in November and continued till January, but the records were continuously supplied till completion. In three places portions of the town were revised, owing to changes since survey, due to widening of roads, erection of fresh buildings, or their removal.

The discrepancies disclosed at time of attestation have all been corrected; the inaccuracies were unimportant, and were generally in places where the *amin* had great difficulty in taking his chain line. In some localities the *amins* had to climb the houses and measure the roofs for the dimensions, and then drop the chain for the survey of the interior details of the squares.

550. As no orders have been received to survey the Cuttack cantonments on a large scale, the 2-inch scale survey made in 1892-93 must be utilized for the completion of the standard sheets.

Demarcation of the Sukinda—Dhenkanal boundary.

551. During last recess an application was made by the Raja of Sukinda (a permanently-settled *pargana*) to the Commissioner of Orissa for the demarcation of the boundary between that estate and killa Dhenkanal, of the Tributary Mahals, according to the line of boundary shown in the topographical survey map on the 1-inch scale of 1853, as there had been no previous revenue survey.

552. In April a native surveyor was deputed on this work. He commenced the survey from the admittedly correct tri-junction of *pargana* Balrampur, district Cuttack, killa Sukinda, and killa Dhenkanal, the position of which had been determined by the cadastral survey of season 1891-92.

A check azimuth was observed at the initial station; the boundary by the previous topographical survey was enlarged by pentagraph to the 4-inch scale, by which the sub-surveyor was guided as to the direction of his lines, and on the field book were recorded the offsets to boundaries of undisputed possession.

The lines were closed on the G. T. Survey station Doitari, lat. 21°06′, long. 85°51′. Seven azimuths were observed, 312 angles taken, and 79¼ miles of chaining were run; the stations were marked for future identification by burnt clay cylinders or by marks on rocks and on protruding roots of trees.

Where the boundary runs through jungle, the alignment on the map of previous survey was accepted: where streams form the boundary there was no difficulty, for it was immaterial whether the streams as enlarged by pentagraph

coincided exactly or not with the true position according to present survey: in general, the agreement was good, though the sinuosities somewhat differed.

Survey of the Balasore District.

553. The detachment for the continuation of the cadastral survey of the Balasore district, on the 16-inch scale, left recess quarters at Cuttack on 27th November, reached Balasore (the centre of operations) on 29th, commenced field work on 1st December 1893, and closed it on 29th May 1894.

554. The area cadastrally surveyed during the season amounts to 649 square miles and lies in the northern portion of district Balasore, between lats. 21°15′ and 21°45′ and long. 87°30′; it comprises 1,567 villages, and 732,749 fields. The survey is mapped in 1,486 sheets. The cost has been ₹84,889, and the cost-rates are, for the cadastral survey, ₹75·2, and for the records ₹70 per square mile.

555. The record of rights has been completed in all the *mauzas* that have been cadastrally surveyed. The average size of field calculated on the area of record writing is 0·057 of an acre.

Registers of proprietors and statements of tenure and intermediate tenure-holders were copied from the Collector's registers and supplied by the Settlement Officer, who used his own establishment for this work.

556. Of village boundary disputes, 447 were submitted this season to the Revenue Officers for settlement (of these 16 fall within Balasore town); 209 disputes have been settled and returned for correction of the maps. Of the disputes of 1892-93, 183 yet remain in the settlement office.

557. The decisions of the disputes between Balasore and Keonjhar State of the Tributary Mahals have not yet been communicated, which is probably due to the troubled condition of that State. Disputed boundaries between Moharbhanj and Balasore, and between Nilgiri and Balasore were also surveyed and submitted for settlement.

558. The town of Balasore, within municipal limits, was surveyed for the most part on the scale of 32 inches to the mile; the overcrowded parts on the scale of 64 inches to the mile. It comprises 28 *mauzas* and the area is 2,761·18 acres, of which 2,635·81 acres were surveyed on the 32-inch scale and 125·37 acres on the 64-inch scale. The *khasra* numbers amount to 19,396.

559. At the request of the municipality, several lines of levels were run through the town for a contemplated drainage scheme. The expense of levelling, and the difference of cost of surveying on a larger scale than what is required for settlement purposes, has been met by a grant of ₹1,400 from the municipality, which sum also covers the cost of a complete supply of tracings. Nineteen miles of levels have been run with 373 fixings of the instrument. The first series emanates from the bench-mark at the circuit house verandah, which is 59·246 feet abo ve sea-level, and closes on bench-mark on No. 101 bridge, which is 32·35 feet above sea-level. The first series supplied data for the subsequent ones. Several theodolite stations of the traverse survey were connected with. Numerous marks are on culverts and other masonry objects. The average error is 0·009 feet per mile.

The permanent marking of the tri-junctions was effected after the cadastral survey was done, as their true positions could not be ascertained beforehand.

The cost of the town survey has been ₹2,036, and the rate per square mile ₹473·5.

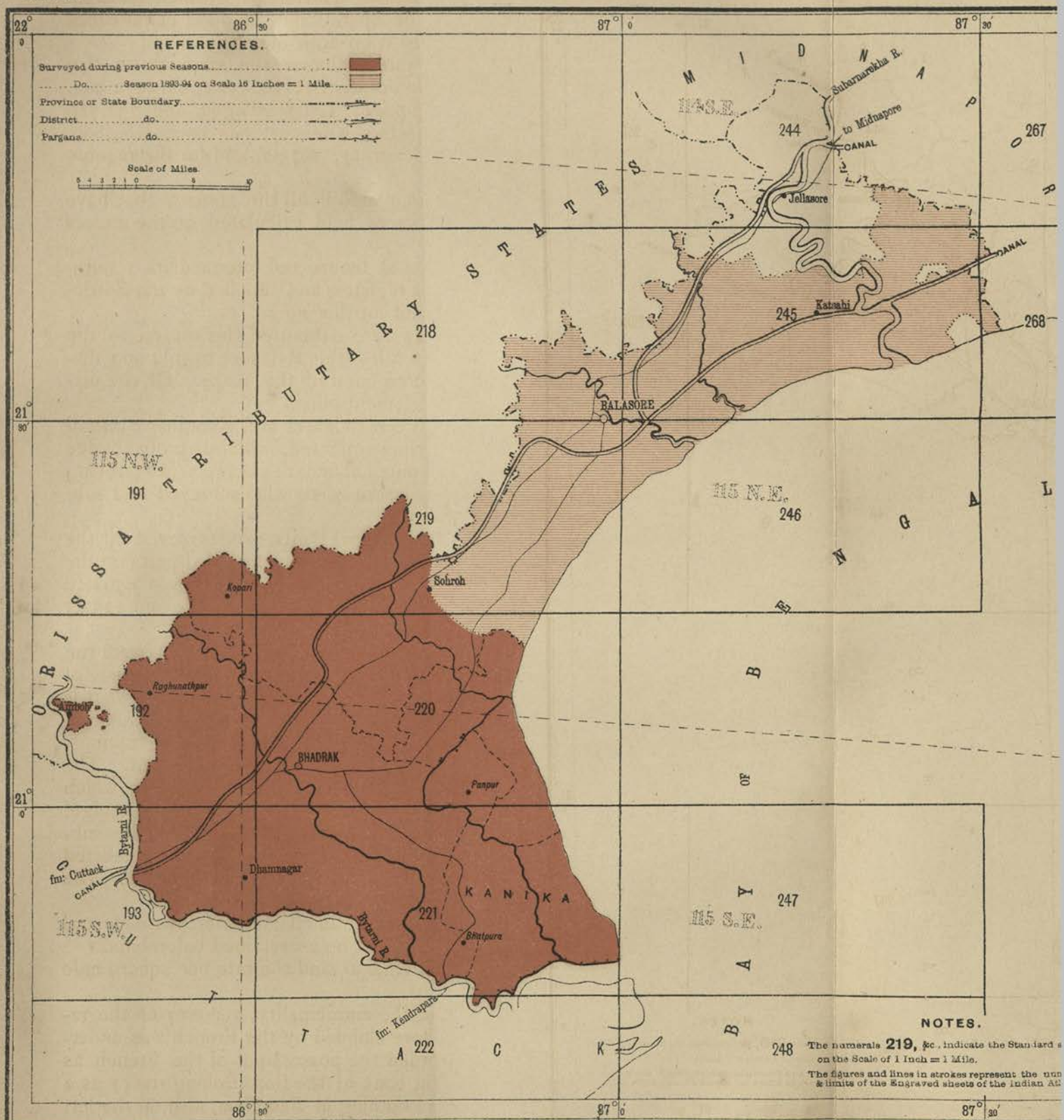
560. In connection with the survey of the municipality, a survey on the 32-inch scale of the lands in Purana Balasore claimed by the French was undertaken. The revenue survey of 1841 recorded the possessions of the French as 24 acres in Purana Balasore, on the right bank of the Boro Bolong river; as 2 roods in Ghorapada on the left bank; and nothing in Bainchua, also on the left bank; whereas 9·27 acres are now admitted on the ground, by the British *zamindárs*, to belong to the French in Bainchua.

In 1892 the lease of the French lands was taken up by Raja Boikonto Nath De, a *zamindár* of Balasore, who in his zeal to repress the irregularities which were reported as prevalent within the French possessions, came in conflict with the preceding lessee, Raghunath Mahapater, which led to the latter's arrest in Purana Balasore. It then became a matter of dispute whether the arrest was made

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF ORISSA, DISTRICT BALASORE.

1893-94. No. 8 I



Ref. No. 480. S. I. D.—Jan. 93.—1,792.

Photo., S. I. O.

No. 311-9

within British or French territory, and on this a claim was made on behalf of the French to certain lands, which have been surveyed on the 32-inch scale. These comprise 749 plots; area 223·68 acres. The two roods of the revenue survey in Ghorapada have been destroyed by the river.

561. The detail survey of the district was checked by 2,132 linear miles of test survey, of which 931 miles were done by means of independent *partals*, and the remainder by native inspectors, which gives an average of 3·13 linear miles of test per each square mile of survey. Most of the village sites were examined *in situ*, as several sites had to be re-surveyed at the early part of the season; it had the desired effect of ensuring the subsequent correct survey of the houses and homesteads.

Of the record writing the survey officers checked 3,931 *khasra* entries and 138,496 entries were tested by native inspectors, which gives an average of 19 per cent. of the total entries tested.

562. In the *parganas* of district Balasore surveyed during this season, there was marked ill feeling between the *zamindárs* and the *rayats*. The *zamindárs* are in general absentees, residing either in the town of Balasore or in Calcutta. In almost every village there are rival factions of the *zamindárs'* people and the *rayats*, and the disappointed party in a dispute immediately imputes bribery and corruption to the *amin*, or inspector: in *pargana* Dararachour especially the *zamindárs* and *rayats* are in avowed hostility. Every dispute, however frivolous, Mr. Ewing states, has been recorded when brought to the notice of the *amin* or inspectors.

Survey of the Jagannath Temple Lands, Puri District.

563. The Government notification, under the Tenancy Act, appeared on the 5th March 1892, directing a survey to be made and a record of rights prepared in certain *mauzas* and revenue-free estates belonging to the Temple of Jagannath.

564. The revision survey of these temple lands in the sub-division of Khurda was taken up during May 1894. The survey had been originally done on the 32-inch scale in 1877-78, when the entire subdivision, which is *khas mahal*, was surveyed, but the record of rights had not been written. The revenue is collected by the Raja of Puri, who is the Superintendent of the Jagannath Temple at Puri, and it is expended on the maintenance of the temple. The application for revision and writing of the records of rights was made last season by the Rani of Puri (mother and guardian of the minor Raja of Puri), and Rs. 6,000 has been deposited by her to defray the expenses.

565. The subjoined statement exhibits the work completed in survey and *khanapuri*:—

PARGANA.	Number of villages.	Number of sheets.	Number of fields.	Area in square miles.
Zilla Tappang . . .	68	227	50,476	48·7
„ Rameswar. . . .	76	285	48,165	56·0
TOTALS .	134	512	98,641	104·7

566. The *khanapuri* of the lands revised was also completed. The checking of the survey was done by Babu Nilmoni Chatterji, an officer of the survey, and by native inspectors; there were 55 miles of independent test lines run and 130 miles by inspectors, which combined gives an average of $1\frac{3}{4}$ miles of test to each square mile of survey.

567. The cost has been R3,032 for survey, and R2,822 for records. The rates per square mile are R29 and 27, respectively.

Demarcation of the Orissa—Madras boundary.

568. At the close of the season in June 1894, a native surveyor was deputed to the Chilka Lake, to determine the positions (on the ground) of three

CENTRAL PROVINCES SURVEY.

1893-94. **INDEX TO THE SURVEY OPERATIONS IN DISTRICT BILASPUR.** No. 9 PARTY.

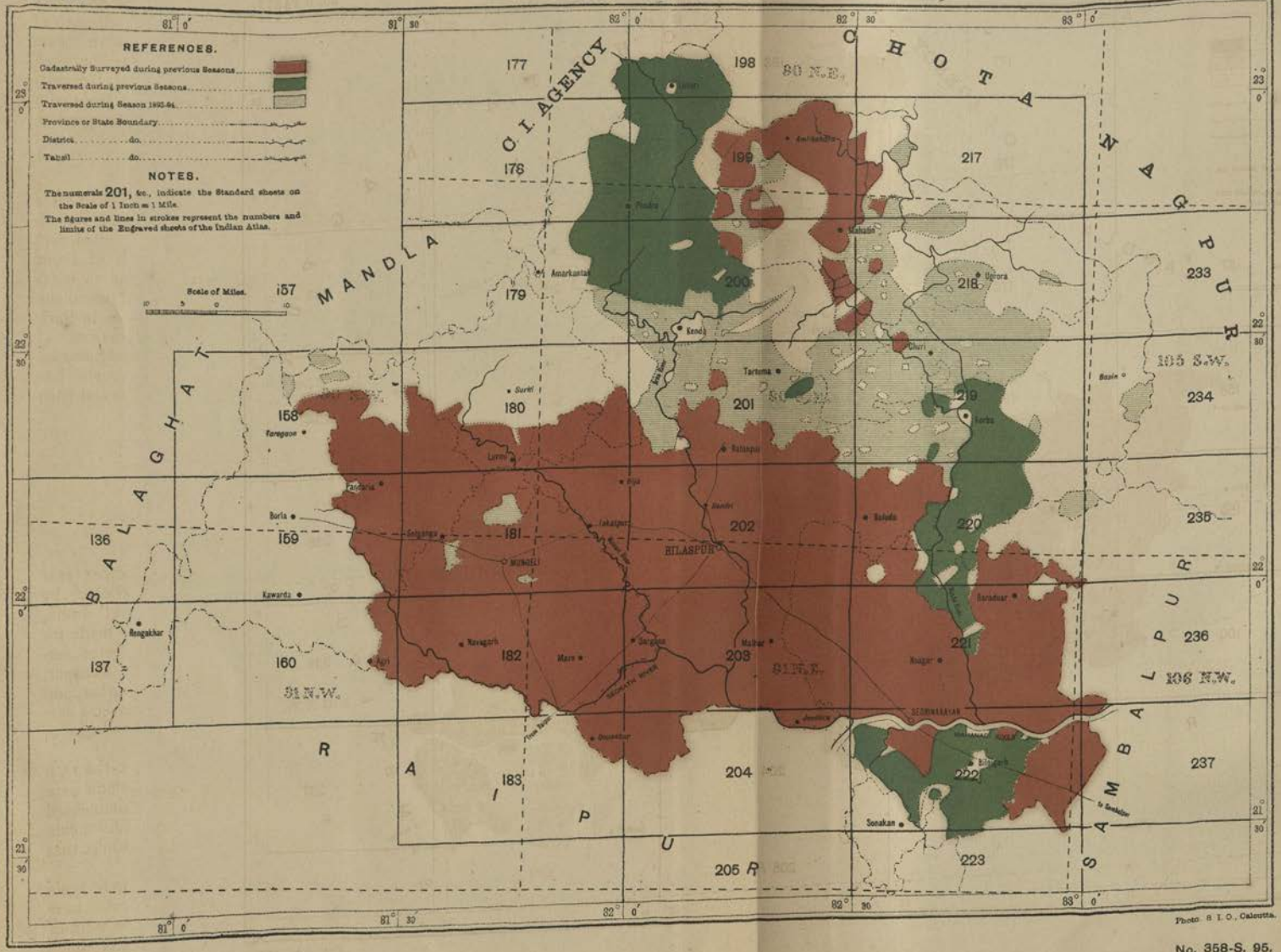


Photo S. I. O., Calcutta.

No. 358-S. 95.

Reg. No. 384, S. I. D.—Mar. 94—360.

salient points which had been decided on by Messrs. Horsfall and Savage, Collectors of Ganjam and Puri, respectively, in the year 1887; three pillars were erected on the sites ascertained by the surveyor and approved by Mr. Maude, Settlement Officer of Orissa, who personally visited the ground with the Sub-divisional Officer.

The boundary passes through water at different angles corresponding with the configuration of the lake; so these points of deflection could not be marked within the lake, for though very shallow in the summer season, it is never dry.

The pillars are erected on the following points:—(1) Where the boundary between Khurda and Ganjam meets the Chilka on the western shore; (2) where the boundary between *pargana* Bajarkot, district Puri, and Ganjam meets the Chilka on the south-western shore; and (3) where the boundary between *pargana* Bajarkot, district Puri, and Ganjam meets the sea (Bay of Bengal). The pillars of stone and mortar constructed at (1) and (2), are 2 feet under ground, and 3′×2′×2′ above the surface; that at (3) is 5 feet under ground, and 5′×2′×2′ above the surface.

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569. The cadastral survey of all the temporarily settled areas in the Orissa Division has now been completed with the exception of a few scattered *mahals* in killa Aul, the position and extent of which have not yet been ascertained, and these will be cadastrally surveyed in the ensuing season. An area of about 1,060 square miles of permanently settled estates however remains to complete the survey of the Orissa Division, of which 687 square miles lies in the Cuttack district, 215 square miles in Balasore and 158 square miles in Puri. These areas will be surveyed on the 2-inch scale during the ensuing season.

570. The Orissa detachment was inspected by the Director, Bengal Surveys, from the 15th to the 23rd March 1894. He reports that Mr. Ewing, who has been in charge of the various operations of the detachment, has as usual been unsparing in his exertions.*

TRAVERSE SURVEYS.

CENTRAL PROVINCES.

No. 9 PARTY.

571. The retention of this party in the Central Provinces for another year having been sanctioned by the Government of India, arrangements were made for continuing the traverse surveys in districts Bilaspur, Sambalpur, and Balaghat, and to undertake the traverse survey of about 600 villages in the *zamindâri* estates of district Chanda.

Personnel.

Mr. E. J. Jackson, Officiating Superintendent, 2nd grade, in charge from 14th November 1893.
Mr. H. Dowman, Extra Assistant Superintendent, 3rd grade, in charge up to 13th November 1893.
Mr. C. George, Sub-Assistant Superintendent, 1st grade.
Mr. C. H. Johnson, „ „ 2nd „
Mr. G. Rae, „ „ 3rd „
46 surveyors, sub-surveyors and others.

572. The recess office was closed and the party left Kamptee on the 13th November 1893, the field establishments assembling at three camps which were formed at Chanda, Bilaspur and Raipur on the 15th idem; they commenced field work soon afterwards. The head-quarters office and the establishments from Chanda and Raipur returned to Kamptee on the 3rd June 1894, whilst that from Bilaspur continued work until 24th June.

573. The portions of country allotted for traverse operations were again much scattered, causing a larger amount of chaining than would otherwise have been necessary for the actual area required to be traversed. Thus the work of the Bilaspur camp covered an area of upwards of 1,700 square miles, of which

* Mr. Ewing reports as follows regarding his Assistants:—
Mr. E. F. Berkeley was ailing during the field season, but notwithstanding has done a fair share of work. Mr. Nilmoni Chatterji has improved and done good work.
The following members of the native establishment are well reported on:—
Jagobundho Kanungo, Jowala Pershad, Baldeo Sahai and Nazir Husein.

CENTRAL PROVINCES SURVEY.

1893-94. INDEX TO THE SURVEY OPERATIONS IN DISTRICT BILASPUR. No. 9 PARTY.

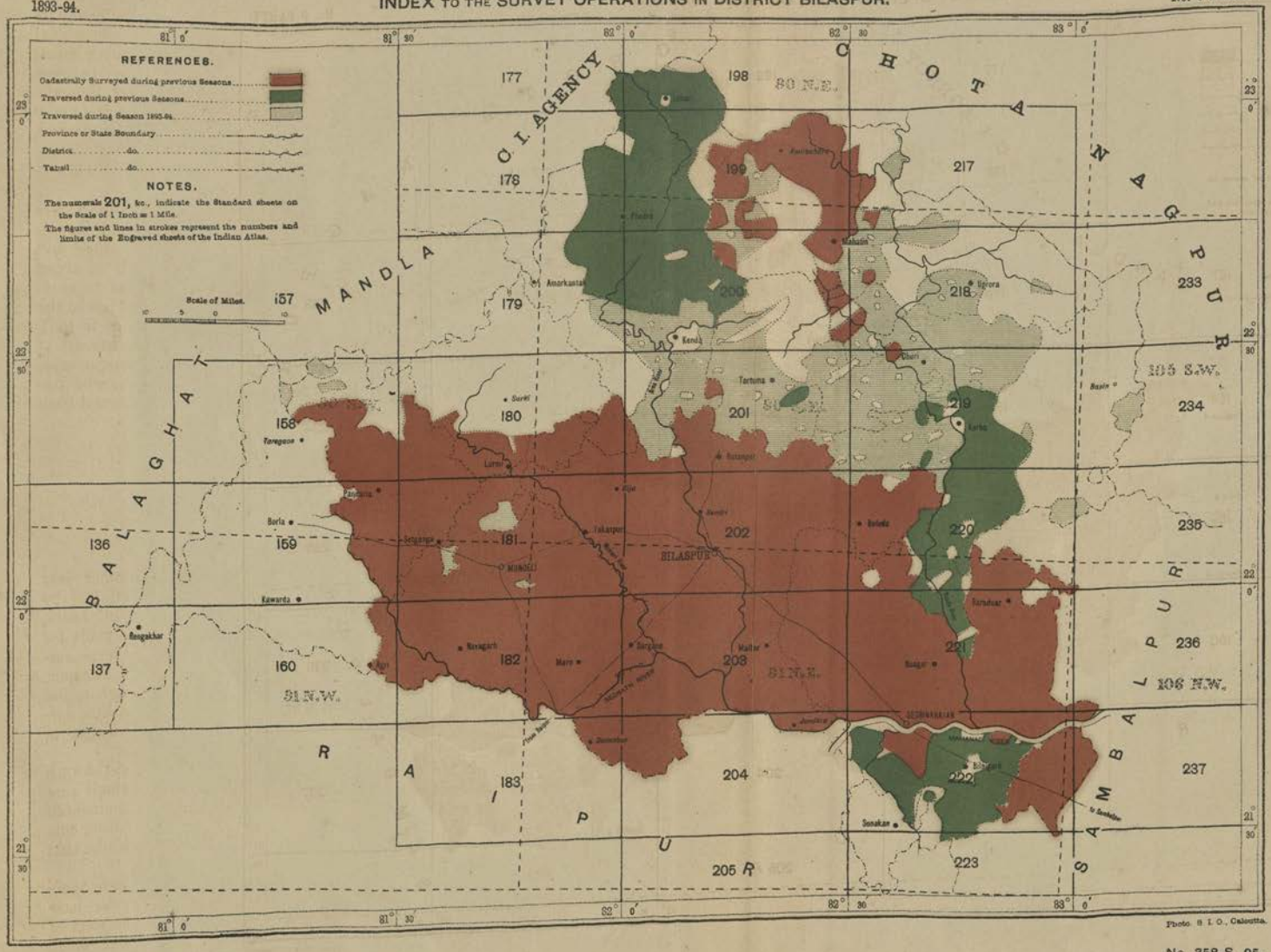


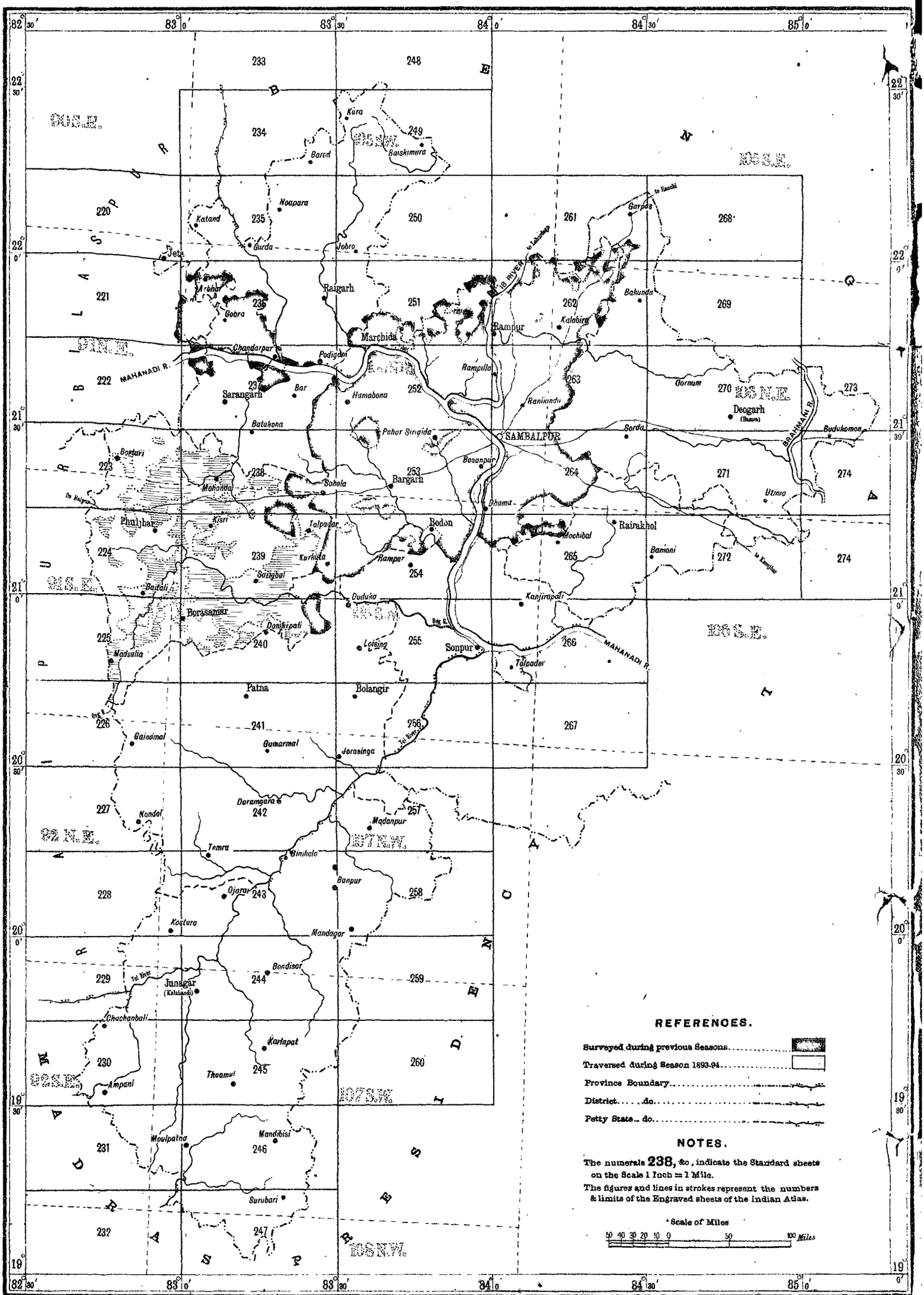
Photo. S. I. O., Calcutta.

No. 358-S. 95.

Reg. No. 534, S. I. O.—Mar. 95—960.

CENTRAL PROVINCES SURVEY.

1893-94. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT SAMBALPUR.** No. 9 PARTY.



REFERENCES.

Surveyed during previous Seasons.....

Traversed during Season 1893-94.....

Province Boundary.....

District.....do.....

Petty State...do.....

NOTES.

The numerals **238,** &c, indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Scale of Miles

50 40 30 20 10 0 50 100 Miles

Photo. S. I. O., Calcutta.

Reg. No. 501. S. I. D.—Mar. 95.—550.

No. 357-S. 95

CENTRAL PROVINCES SURVEY.

1893-94. INDEX TO THE TRAVERSE SURVEY IN DISTRICT BALAGHAT. No. 9 PARTY.

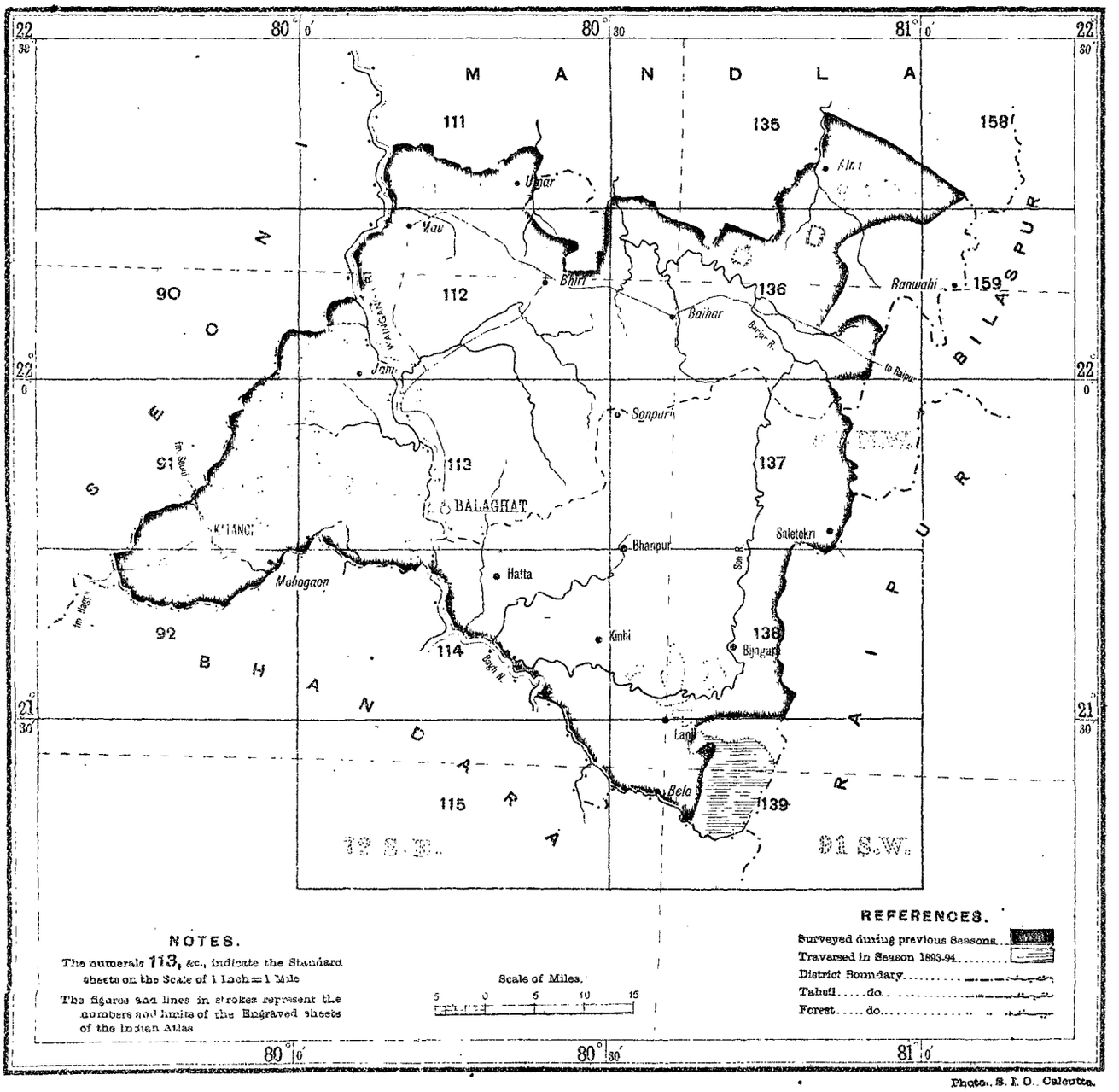


Photo. S. I. O. Calcutta.

No. 356-S. 95.

CENTRAL PROVINCES SURVEY.

1893-94. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT CHANDA.** No. 9 PARTY.

REFERENCES.

Traversed during previous Seasons.....

.....Do.....Season 1893-94.....

Province or State Boundary.....

District.....do.....

Tahsil.....do.....

Forest.....do.....

NOTES.

The numerals **98**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Scale of Miles

Reg. No. 695 S. I. D.—Mar. 95.—550.

Photo., S. I. O., Calcutta.

No. 361-S. 95.

1,500 square miles only were fully traversed; and in addition to this 17 scattered villages in Balaghat were completed. The villages in Chanda of which the traverse survey was required comprised an area of 956 square miles only, but they were scattered over an area of 2,340 square miles, and had all to be connected. In Sambalpur, four *zamindâri* estates aggregating 845 square miles in area, which had been left unsurveyed during the previous season, were completed.

574. The operations in the above districts have been of exactly the same character as in previous seasons, the object being to furnish skeleton plots of traverse points on the 16-inch scale to the Settlement Department on which to base the survey of the fields. The traverse lines averaged from 1 to 30 chains in length and as closely as possible followed the boundaries; when necessary sub-traverse lines were run so that the maximum distance apart of stations in cultivable land was 30 chains. The amount of work executed is considerably in excess of that of last year, as the native establishment was strengthened with a view to completing all the traverse survey required by the Government of the Central Provinces. This, however, could not be accomplished, mainly on account of an abnormal amount of sickness in the early part of the field season, which greatly retarded work. The area of plots supplied amounts to 3,397 square miles, and the number of linear miles of chaining to 11,482, as against 2,316 square miles and 9,431 linear miles reported last year. The cost-rate per square mile is consequently less, being for the traverse survey and stone embedding R26, whilst that of last year was R34.

575. The out-turn of work for the season is shown in the following tabular statement:—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Bilaspur	724	945	25,553	1,500
Balaghat	47	14	1,404	96
Chanda	451	957	22,126	956
Sambalpur	619	909	21,570	845
TOTALS	1,841	2,825	70,653	3,397

576. Of the total number of traverse stations fixed, 45,589 stations were marked with embedded stones and 16,024 others were either on tri-junction pillars or on rocks marked *in situ*, making a total of 61,613 permanent marks in an area of 5,011 square miles (which is the gross area covered by the survey). This gives an average of a little more than 12 marks per square mile. The total cost of the stones embedded amounted to R2,833; their carriage cost R2,909 and their erection R5,212, or R10,954 in all, and the cost-rate of the marking is thus R2·2 per square mile. Receipts were taken from the *zamindârs* for the protection of the survey stations. In addition to these, printed notices, on which were plotted the positions of the stations on the 2-inch scale, were prepared in duplicate, one copy being sent to the Deputy Commissioner and one to the *zamindâr*.

577. Two chains, one of 100 feet in length and the other of 66 feet, were used throughout, and the linear measurements were tested by connections with 12 trigonometrically fixed stations. The angular measurements were checked by observations for azimuth at 496 stations.

578. No maps existed showing village boundaries; consequently the sub-surveyors were often obliged to follow the boundaries as pointed out to them by the headmen. In many instances two different lines were shown, necessitating a traverse along each to enable the Settlement Officer to decide the dispute. In Bilaspur many such disputes arose, and constant reports had to be made to the Deputy Commissioner in consequence. The demarcation was much more satisfactory in Chanda and Sambalpur; the boundary disputes there were few in number, and were quickly settled by the Settlement Department.

579. The country traversed was on the whole free from hills, but in many places lines had to be cut through jungle where villages touched on forest reserves.

580. In the early part of the season there was a great deal of sickness in the Chanda and Bilaspur districts, and at one time Messrs. Jackson, Dowman, George and Rae, as well as 15 sub-surveyors, were all prostrated by fever of a bad type which was difficult to shake off. During December, January and February, 50 per cent. of the establishment were laid up, and it was some time before the men could return to their work on account of weakness; indeed some had to be discharged. Of the *khalásis* 21 died from fever.

581. During the field season, that is, up to the end of May 1894, the 16-inch plots of 1,131 villages, on 2,134 sheets, were supplied to the Settlement Department, and during the recess, all the remainder were given in with the exception of those of 14 villages, which will be despatched in November or December after the revision surveys have been completed.

582. The party was inspected in the field by the Deputy Surveyor-General, who visited the Bilaspur and Chanda camps in January 1894. That officer also proceeded to Pachmarhi in May 1894, where he met the Chief Commissioner and the Commissioner of Agriculture, and conferred with those officers on the question of retaining the party for yet another season. It was then shown that there would still be employment enough for it in traversing those villages in Chanda and Bilaspur which it was found impossible to finish this year, in completing forest and *zamindári* boundaries and in traversing any other villages of which it has since been found advisable to have correct plots. An application was therefore made to the Government of India for the retention of the party in the Central Provinces during 1894-95, which was sanctioned in letter No. 1945-110, dated 13th July 1894, from the Government of India, Revenue and Agricultural Department, to the Chief Commissioner, Central Provinces.*

GEODETIC.

LATITUDE OPERATIONS.

No. 22 Party, Astronomical.

583. Latitude operations were continued by this party under Captain Burrard, R.E., on the Jodhpore Meridional Series of the Great Trigonometrical Survey. Eight stations were observed at in all, six of which were situated near the meridian of 72°, the remaining two being the Agra and Amritsar longitude stations. The instrument employed was the zenith sector No. 1, and the observations were taken by Talcott's method.

Personnel.

Captain S. G. Burrard, R.E., Deputy Superintendent, 2nd grade, in charge.
Aulad Hussein, Sub-Assistant Superintendent, 3rd grade.
Govind Balwant Joshi, recorder.

584. Talcott's method of observing has been generally regarded by all authorities as very superior to the Sector method, in that it renders a graduated limb unnecessary. But in practice, the errors that arise from a graduated limb read by micrometers, are found to be considerably less than the errors due to imperfect graduation of the levels, and in India the substitution in late years of the Talcott method for the old Sector method has not been accompanied by any improvement in the accuracy of results. Levels cannot yet be ground to the same degree of precision as a limb can be graduated, and where the accuracy of a final result depends on the measurement of a dislevelment, it is an evident advantage to have this measurement made by two levels instead of one.

With the Sector method two levels were always employed, whilst but one is used with the Talcott, and though the elimination of the limb renders the Sector an easier and simpler instrument to work with, it is a questionable point whether the gain in accuracy of observation, brought about by this elimination, is not more than lost by the abolition of one of the levels. The two observers, who have worked the Talcott method in India, both also complain of the impossibility of determining the value of their micrometer screw with sufficient accuracy for the

* The Officer in charge reports well of all his Assistants, and particularly of Mr. C. George. Of the Natives he selects the following as having done especially good work, *viz.*, Ganpat Rai, Sadat Ulla, Nathuram, Hilaluddin, Alla Bux, Mojid Ulla, Lall Mohun Gungopadhyaya, Narsu Dinkar, Upendra Nath Mukerji, and Manohar Daji.

large measurements that must of necessity be made under this system of observation.

585. The levels employed in the last two years are by Holmes and are of the finest make, but it was not known until lately that the liquid they contained was chloroform and that it was liable to decompose, though enclosed in an hermetically sealed tube. The liquid in all these levels has been gradually contracting, and in some the bubbles are now too long for use. The contraction of the liquid has probably impaired the accuracy of the levels, and, perhaps, rendered the latitude observations more liable to error. In future the chloroform will be changed annually.

586. The results of the season's work are given in Captain Burrard's narrative report in the appendix. Almost all his stations, like those of 1892-93, are situated in the Great Desert between Ajmere and Karachi, which, owing to the entire absence of hills, should be one of the most suitable spots in the world for astronomical observations.

The observations at Amritsar, where the Himalayas can be seen to the north, show considerable southerly attraction, and thus tend to corroborate in a remarkable way the theory first propounded by General Walker in 1867, that the northerly attraction of the Himalayas is more fully compensated in the western than in the eastern plains.

587. An interesting and valuable discussion by Captain Burrard on local attraction in India, based on the data obtained by the Trigonometrical Survey, is printed in the appendix. Captain Burrard clearly shows how greatly the problem of determining the figure of the earth is complicated by the fact that the deviation of the plumb line from the normal, due to local attraction, varies so greatly, and frequently so unaccountably, from place to place.

588. The Superintendent, Trigonometrical Surveys, inspected this party in June 1894, during the recess at Mussooree, and was thoroughly satisfied with its efficiency.*

No. 23 Party, Astronomical.

589. This party was engaged in continuing the series of determinations of latitude, which was begun in the season 1892-93, and which was then carried from Bombay as far as Achola H. S., the last *azimuth* station of the Bombay Longitudinal Series, situated in latitude 18° 14′ 48,″ longitude 77° 1′ 48″.

Personnel.

Lieutenant G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 2nd grade, in charge.
Babu Hanuman Prasad.
Babu Lal Singh, recorder.

590. The work this year comprised the determination of the latitudes of seven stations. It began with the determination of the latitude of the Bolarum longitude station, and after that followed the Bider Longitudinal Series from Pirmulo H. S., nearly due north of Bolarum, to Waltair on the east coast, the longitude station being the point there selected. The instrument in use was Troughton and Simms' zenith telescope, and the method of observation that known as Talcotts'. The details and results of the season's work will be found in Lieutenant Lenox-Conyngham's narrative report in the appendix.

591. The principal deduction to be drawn from the season's work is, as pointed out by Lieutenant Lenox-Conyngham, that a determined value of a micrometer screw must not be regarded as an invariable quantity, but that it depends on temperature and the adjustment for focus, and that the best practicable method of discovering what its actual value at any particular station was, is to take an approximate value and thence to compute a series of preliminary values of the latitude, and from them deduce a correction applicable to the assumed micrometer value. It is satisfactory to note, however, that by attending to certain precautions, all danger of vitiating the final latitude by using a wrong micrometer value may be avoided, although, unless the correction above alluded to is determined and applied, the probable errors will be larger than they should be. The considerable amounts and persistence in sign of the difference between the astronomical and geodetic latitudes along the whole series, from the west to the east coast, is remarkable.

* Captain Burrard commends the services rendered by Sub-Assistant Superintendent Aulad Husein and favourably mentions Babu Govind Joshi.

592. The only *contretemps* which was encountered was the, at first, inexplicable failure of the level mounted on the zenith telescope on account of the diminution of the amount of liquid. This has been explained by the maker, Mr. Holmes, to be due to a contraction in bulk of the chloroform with which they are filled, owing to a gradual chemical change. Though this is an undoubted disadvantage, yet it is not so great a one as to counterbalance the immense advantage for accurate work which levels filled with chloroform have over those filled with spirit.

593. This party was inspected in June 1894 by the Superintendent, Trigonometrical Surveys, who found it in a state of high efficiency.*

TIDAL AND LEVELLING OPERATIONS.

No. 25 PARTY.

594. The direction of these operations was in the hands of Lieutenant-Colonel J. Hill, R. E., throughout the year, with the exception of the first three days of it, during which he was on privilege leave and the party was in charge of Lieutenant Morice, R.E., upon whom Colonel Hill again reports in the highest terms.

Personnel.

Lieutenant-Colonel J. Hill, R.E., Superintendent, 2nd grade, in charge.
Lieutenant C. C. D. Morice, R.E., Assistant Superintendent, 1st grade.
Mr. G. Belcham, Extra Assistant Superintendent, 2nd grade.
„ E. J. Connor, Ditto 4th grade.
„ J. Bond, Ditto 4th grade.

Surveyors, etc.

Dhondu Vinayek, Vinayek Narayan, N. V. Apte, 2 native mechanics, and 14 recorders and computers.

TIDAL OPERATIONS.

595. The automatic recording of the tidal curves, their reduction, and the publication of the predicted times and heights of high and low water have been continued, and tidal observations by means of self-registering gauges, have been carried on during the year at thirteen stations, *viz.*:—*Aden*, Maskat, Bushire, *Karachi*, Bhavanagar, *Apollo Bandar* (*Bombay*), Prince's Dock (Bombay), Minicoy, Trincomalee, *Kidderpore*, *Rangoon*, Mergui and *Port Blair*. The seven tidal stations, whose names are not italicised, are minor stations where observations, as a rule, are taken for five years only: the others are permanent stations, where the minimum period of observations lasts for nineteen years, and where observations should be continued until the whole scheme of tidal operations has been completed. In addition to the observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily, with the object of comparing the actual heights and times of high and low water with those predicted in the Tide Tables, at the following tidal stations, at all of which the tidal observatories are closed:—Cochin, Tuticorin, Colombo, Chittagong, Akyab, Moulmein.

596. The tidal observatories at Mergui and Bhávnagar were closed on the 6th June and 17th August 1894, respectively, five years' observations having been completed at these stations. No new tidal observatories have been established during the year, and no observatory will be closed during 1894-95. The tidal observatory at Bushire was wrecked in a storm on the 19th December 1893; it was re-erected on an iron substructure and the observations were resumed on the 23rd April 1894.

597. Thus since the resumption of systematic tidal operations in 1877, observations have been taken at 33 tidal observatories, of which 22 (including Madras) have been closed on the completion of their registrations and 11 are now in operation.

598. It was reported last year that tidal observations were expected to commence during the field season, 1893-94, at the following three stations:—Madras, Diamond Island (Burma), and Port Albert Victor in Káthiáwár. Serious delay has occurred in the resumption of tidal observations at Madras, due in the

*Lieutenant Lenox-Conyngham reports well of the work done by both his Assistants.

first instance, to the Harbour Trust Board cancelling their previous sanction of a temporary observatory, to work till the north pier of the harbour, with the permanent observatory at its seaward end, was completed, and subsequently due to the completion of this pier being itself delayed. At Diamond Island, the communication between the observatory and the sea, which had been completed just before the monsoon (1893) was entirely blocked during the monsoon and could not be re-opened before the middle of February 1894. It was then thought advisable to watch how the communication would stand the monsoon (1894) before setting up the usual instruments. Regular observations were made, and the communication has been quite free. Observations will accordingly be commenced at the earliest possible date. At Port Albert Victor it is possible, though hardly probable, that the light-house, which Mr. Proctor-Sims, the Bhávnagar State Councillor and Engineer, is building, and which will contain the tidal observatory, will be ready to receive the tidal instruments this year. At Porbandar, in Káthiáwár, the State Engineer has been taking tidal observations for some time, and it is possible that these may be supplemented by a more extended series of observations to be taken with a self-registering tide-gauge under arrangements organised by Colonel Hill.

599. All the tidal observatories, with the exception of Aden, have been inspected. The inspection of Aden, delayed owing to the wrecking of the Bushire observatory upsetting the field season's programme, will be carried out early in the ensuing season. A detailed account of the working of each observatory will be found in the appendix, where also certain circumstances deserving special notice are reported at Aden, Maskat, Bushire, Karachi, Prince's Dock (Bombay), Minicoy, Trincomalee, Kidderpore, Rangoon, and Port Blair. The only serious interruption of observations was that at Bushire, and they were resumed at that station after an interval comparatively short, considering the nature of the repairs and improvements effected and the remoteness of the place.

The tidal operations of the year may be pronounced very successful, a result due to a great extent to the assistance received from local officials, whose kind co-operation has been acknowledged by Colonel Hill. Colonel Hill in particular expresses his gratitude to Mr. D. Morris, the Port Engineer at Karachi, for his invaluable help in constructing the iron substructure for the Bushire tidal observatory and for the other assistance he afforded in re-establishing the observatory there. Details of this work will be found in the appendix.

600. Colonel Hill discusses in the appendix the future of the tidal operations, and passes under review the work which it will be necessary to carry out during the next few years, at two stations on the west coast, one north and one south of Bombay, and at two others near the southernmost extremity of Burma, one in British territory in the Bay of Bengal, and the other in Siamese territory in the Gulf of Siam ; also subsequently at the tidal stations sanctioned in 1889, namely, Acheen, Bangkok, Perim and Suez.

601. He also summarises the experience accumulated during past years with regard to the pattern of tidal observatories and concerning the instruments used in them. The tidal observatories recently built are considered very convenient patterns. Newman's pattern tide-gauges are held to answer their purpose admirably. The aneroids used, with the exception of a single old pattern instrument and three new pattern ones recently provided, are not considered satisfactory, and the chief reliance is placed on mercurial barometers read four times a day. The anemometers are unsatisfactory: no means exist for testing them at tidal observatories. Their toothed wheels and spirals constantly wear out and require repairs: after such repairs there can be no certainty of their recording wind-velocity with precision.

602. The chart of the tidal and levelling operations showing approximate co-tidal lines, which Colonel Hill stated in his last report that he intended to prepare, is reported to be well advanced, and will, it is hoped, be submitted for publication in the spring of 1895.

603. A new method of reducing tidal observations, elaborated by Professor G. H. Darwin, and very greatly diminishing the amount of arithmetical calculation involved, is being tested by Colonel Hill in conjunction with the inventor and Mr. E. Roberts of the Nautical Almanac Office, and promises to be very successful.

The reduction of the tidal observations have been carried on steadily during the year. Observations for one year at thirteen tidal stations have been reduced: the tabulated values of the tidal constants so obtained will be found in the appendix. Another table is given, showing the variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories for each calendar year of the tidal operations to enable comparisons to be made between the values at each station. The computations for each tidal observatory commence now, as a rule, on January 1st.

In addition to the constants mentioned above, constants to be employed in setting the tide-predictor were calculated for the year 1895 and sent to Mr. Roberts of the Nautical Almanac Office ready for use: he was also furnished with tabulated comparisons for the year 1893 between the predicted times and heights of high and low water at 17 stations published in the Tide Tables for that year, and their values obtained by actual measurement, thus giving him, in a convenient form, information adapted to assist him in improving subsequent predictions, especially at the three principal riverain ports—Kidderpore, Rangoon, and Moulmein.

604. The Tide Tables for 1895 will contain predictions for 35 tidal stations. The new stations, Maskat and Bushire, are added since the last issue.

605. The usual tables, showing the results of the predictions, are given for the year 1893 in the appendix, and may be summarised as follows:—

Percentage of Time predictions within 15 minutes of actuals.

							High water, per cent.	Low water, per cent.
Open coast stations	9	at which predictions were tested by				S.R. tide-gauge	73	68
	4	,,	,,	,,	,,	tide-pole	48	45
Riverain stations	2	,,	,,	,,	,,	S.R. tide-gauge	57	57
	2	,,	,,	,,	,,	tide-pole	78	66

Percentage of Height predictions within 8 inches of actuals.

							High water, per cent.	Low water, per cent.
Open coast stations	9	at which predictions were tested by				S.R. tide-gauge	93	98
	4	,,	,,	,,	,,	tide-pole	98	98
Riverain stations	2	,,	,,	,,	,,	S.R. tide-gauge	68	50
	2	,,	,,	,,	,,	tide-pole	55	59

Percentage of Height predictions agreeing within one-tenth of mean range at springs.

							High water, per cent.	Low water per cent.
Open Coast stations	9	at which predictions were tested by				S.R. tide-gauge	96	95
	4	,,	,,	,,	,,	tide-pole	85	92
Riverain stations	2	,,	,,	,,	,,	S.R. tide-gauge	89	84
	2	,,	,,	,,	,,	tide-pole	86	81

In this summary, as explained in the appendix, the tests by self-registering tide-gauges are the more reliable, especially with regard to time. Subject to this consideration the predictions for time, although not equal to those for height, are undoubtedly very good; and the figures as a whole show a high standard of accuracy.

SPIRIT-LEVELLING OPERATIONS.

606. The regular levelling operations were carried out by Mr. J. Bond, and consisted of a continuous line of double-levelling from Sakti Station of the Bengal-Nagpur Railway, where the work closed at the end of field season 1891-92, to Sambalpur and thence across the Mahánadi, and along or near the alignment of the proposed railway on the south or right bank of the river, to Cuttack, closing at Kendrapára near False Point tidal station, and thus connecting Bombay by levelling with False Point and Calcutta. This line, together with 52½ miles of levelling executed by Mr. Bond in 1891-92, consists of the following two sections:—

(*a*) Bilaspur to Sambalpur, 163 miles.
(*b*) Sambalpur to Kendrapára, 259 miles.

The levelling was carried during the past season over country, the total rises and falls of which amounted to 12,890 feet, and the total outturn amounted to 369½ miles of double levelling, in the course of which the heights of 355 permanent bench-marks, 11 Railway bench-marks, 2 Public Works Department bench-marks, 25 Irrigation bench-marks, 2 stations of the Great Trigonometrical Survey, and 32 temporary bench-marks on the alignment of the proposed railway to Cuttack were determined. This is a good outturn, and very creditable to Mr. Bond, who carried out his appointed work most efficiently, and brought the direct line of spirit-levelling between Bombay and False Point to a successful completion, in spite of many difficulties. The levelling was carried over rough and hilly country, covered with jungle and intersected with numerous streams and water-courses, a difficult and unhealthy region, in which Mr. Bond and his detachment suffered much from illness. The highly satisfactory character of the levelling thus completed may be estimated, by comparing the height of the closing bench-mark at Kendrapára as derived from the tidal station of False Point, with its height as derived from the origin of the line of levels at Kalyán railway station near Bombay. The height derived from the origin is one foot four inches higher than that derived from False Point, and the distance between the points is 1,185 miles.

607. During next field season the levelling operations will be continued from where they terminated last season near Cuttack and extended down the coast to join the line that was brought northward as far as Vizagapatam in 1888, connecting trigonometrical stations of the East Coast Series, and completing the junction by spirit-levelling of all the tidal stations along the eastern coast of India. The standard bench-mark for Calcutta will also be connected with the Kidderpore tidal observatory, and with the spirit-levelling already executed.

608. Some extra levelling at Karachi was found to be necessary by Colonel Hill, who took an opportunity of inspecting the bench-marks laid down there in 1859-60 and in 1883, and found that they had all disappeared, with the exception of one that is gradually sinking and is, therefore, useless. The levelling was executed most satisfactorily by Mr. Belcham; and consisted of a line of the usual rigorous double-levelling, carried from the tidal observatory at Manora to the Karachi base line, a distance of nearly 17 miles, in the course of which 1 important bench-mark of reference (the bench-mark of reference for Karachi, fully described in the appendix), 18 permanent minor or inscribed bench-marks, and 1 Great Trigonometrical Survey station were connected.

609. Colonel Hill adds some remarks on the standard of accuracy of the Survey of India spirit-levelling operations. He defines the procedure employed in the actual spirit-levelling; sketches the general system of lines of double-levelling from sea to sea and along the coasts; and explains that the usual standards of accuracy, by which the error is restricted within such limits as 1 inch per mile, 2 feet or 1 foot per mile, etc., would be useless for these operations, in which the resulting heights can seldom be checked before the levelling has proceeded many hundreds of miles. He lays stress on the close agreement insisted on between the independent results obtained by the two levellers using different instruments, and gives a table showing the maximum and terminal differences thus obtained on six sections (varying from 242 to 360 miles long) taken from the line of levelling between Karachi and Calcutta. The maximum difference between the levellers per 100 miles is seen to be only 0·18 foot on the average of the six sections. An idea of the accuracy of the final results may be formed by inspecting two other tables, which he provides. The first gives eight typical specimens of great lines of levelling connecting tidal stations, and the apparent errors at their terminations. The second gives five specimens of great closed circuits taken at random from the published pamphlets of spirit-levelled heights and their closing errors. The Survey of India, as he remarks, does not profess to keep errors of height within any fixed limits, but prefers turning out the best work possible, and discovering afterwards what its errors may amount to.

Colonel Hill points out that, while spirit-levelling, of which the error does not exceed 1 foot per 100 miles is generally considered to be practically perfect, it will be found that the mean error of the great spirit-levelling operations dealt with in his tables is about 1 foot per 1,000 miles.

610. Several years will be required in order to complete the general scheme of spirit-levelling operations. The portion of the system lying south of a line joining Bombay and Cocanada may be considered as finished: but much remains to be done to the north of that line. Thus, for example, the central or trunk line of levelling requires completion between Bider and Bhopal; a branch is required to join Allahabad and Biláspur and to be continued thence to the tidal station at Vizagapatam: and several other lines of levelling are required in Rajputana, Bengal, and Burma, which can be undertaken when those mentioned shall have been completed.

611. In addition to the regular departmental work of the tidal and levelling party, a considerable amount of extra work had to be undertaken in order to furnish other departments and Local Governments with information applied for by them, the particulars of which are given in the appendix.

612. The office of this party was inspected in September by the Surveyor-General who was well satisfied at the efficient state of the establishment and with the orderly and methodical manner in which the large mass of computations, which have to be dealt with annually are carried out. Colonel Hill who has had charge of those important scientific operations for several years, is entitled to much credit for his able superintendence.*

GEOGRAPHICAL SURVEYS.

OPERATIONS IN UPPER BURMA.

NO. 11 PARTY.

613. This party continued in the charge of Colonel Woodthorpe throughout the year, and was strengthened by the transfer of Lieutenant Ryder, R.E., from No. 18 Party at the commencement of the field season.

Personnel.

Colonel R. G. Woodthorpe, C.B., R.E., Superintendent, 2nd grade, in charge.
Lieutenant C. H. D. Ryder, R.E., Assistant Superintendent, 2nd grade.
Mr. P. J. Doran, Extra Assistant Superintendent, 5th grade.
Mr. W. M. Kelly, Extra Assistant Superintendent, 6th grade.
Mr. H. G. Shaw, Sub-Assistant Superintendent, 2nd grade.

Surveyors and Sub-Surveyors.

Mahmud Hosein, J. Sebastian, Ramsabad, Abdul Rahim, Kudratullah, Mowin Ram, Sita Ram, Nuruddin and 3 apprentices.

614. The party was divided into two detachments, one of which, under the personal superintendence of Colonel Woodthorpe, continued the delimitation of the Anglo-Siam boundary between the States of Keng Tung and Keng Cheng, which had been commenced in the previous season, while the other, under Lieutenant Ryder was engaged in the more regular work of the party, *viz.*, the survey of the Southern Shan States, on the scale of 1 inch=4-miles. A surveyor was also detached from the party to proceed to the Karenni country to fill in a gap in the existing map.

615. Leaving recess quarters at Bangalore at the end of October 1893, the party reached Fort Stedman by the end of November, that place being made the head-quarters for the field season as last year.

616. Colonel Woodthorpe experienced considerable delay by the late arrival of the transport coolies for the delimitation party, which was due to delay in obtaining the necessary sanction from the Government for their entertainment and to further delay in their enlistment and journey. The coolies engaged for the work were Khasias from Assam, who were sent *viâ* Calcutta, where unfortunately they had to remain three days for the steamer and contracted cholera, from which six of them died before reaching their destination.

617. The delimitation party consisted of the following officers:—

Colonel Woodthorpe, R. E., in charge of surveys.
Captain W. H. Dobbie, Commanding escort.
Lieutenant E. Carrick, Commanding Mounted Infantry.
Mr. G. C. B. Stirling, Political Officer.
Two native surveyors of the Survey Department.

* Colonel Hill reports most favourably of Messrs. Belcham and Connor and Surveyor Dhondu Vinayek in the tidal division and of Mr. Bond and Surveyor Vinayek Narayan in the levelling division. The staff of native mechanics, surveyors, sub-surveyors, and computers are reported to have worked well and given satisfaction.

NORTH EASTERN & SOUTH EASTERN FRONTIER SURVEY.

INDEX TO THE GEOGRAPHICAL SURVEY IN UPPER BURMA.

1893-94. Nos. 11 & 21 PARTIES.

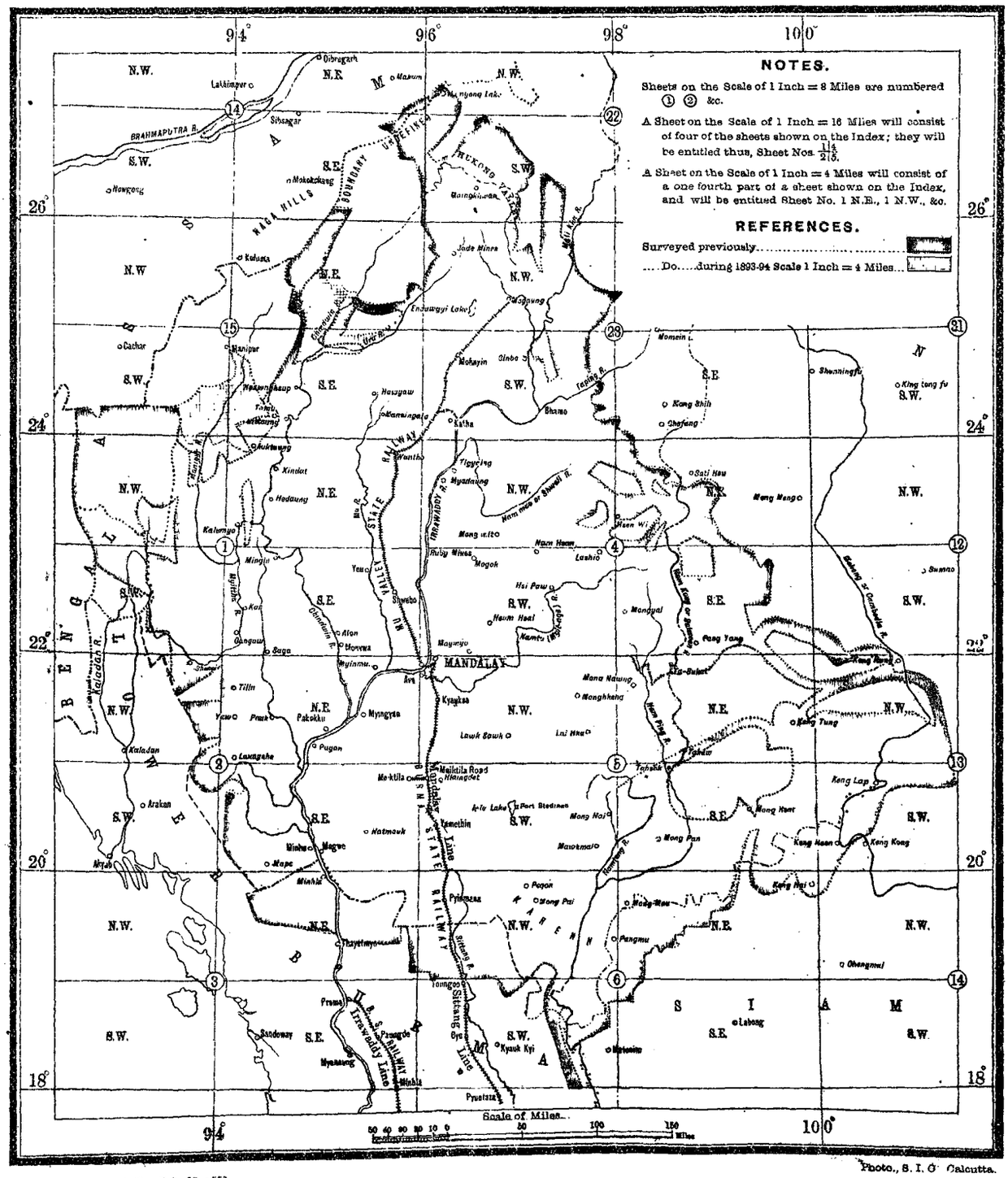

NOTES.
Sheets on the Scale of 1 Inch = 8 Miles are numbered ① ② &c.
A Sheet on the Scale of 1 Inch = 16 Miles will consist of four of the sheets shown on the Index; they will be entitled thus, Sheet Nos. 1 1/4 2/3.
A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one fourth part of a sheet shown on the Index, and will be entitled Sheet No. 1 N.E., 1 N.W., &c.
REFERENCES.
Surveyed previously.....
.....Do.....during 1893-94 Scale 1 Inch = 4 Miles...
Scale of Miles...
94°
96°
98°
100°
26°
24°
22°
20°
18°
MANDALAY
BRAHMAPUTRA R.
IRRAWADDY R.
SALWEEN R.
MEKONG R.
BENGAL
ASSAM
BURMA
SIAM
N.W.
N.E.
S.W.
S.E.

Photo., S. I. O. Calcutta.

Reg. No. 528, S. I. D.—Feb. 95.—350.

No. 336-S. 95.

The escort comprised about 100 sepoys and 35 mounted infantry. The party left Fort Stedman on the 23rd December 1893 and reached Keng Tung on 17th January 1894, where it was joined by Captain Walker, Intelligence Officer. After a short delay at Keng Tung, the mission proceeded to Hongluk, and on the way the two native surveyors were detached to select stations in advance and to clear hills for triangulation. This work was steadily proceeded with for a fortnight, when it was brought to an abrupt conclusion by hazy weather which set in earlier than usual. The triangulation was therefore not satisfactorily completed, but enough was done to give a good check on the topography, and Colonel Woodthorpe hopes to be able to extend and improve it during the ensuing season.

618. In the meantime, Colonel Woodthorpe and Mr. Stirling had been busily occupied in ascertaining and demarcating the boundary from Hsup Yawng onwards, though considerable difficulty was found in ascertaining its course, owing to the ignorance on the subject prevailing among the men sent with them to point it out, and to the unsettled habits of the tribes resident in its vicinity, who are constantly changing the sites of their villages from one side to the other, though continuing to consider themselves as belonging to the territory from whence they originally came. Much confusion is caused by these migratory habits of the villagers on the boundary, and Colonel Woodthorpe reports that it is impossible to consider the boundary as permanently settled. For the same reason he has omitted to show these villages in the map, as it would be most unlikely that a surveyor visiting the neighbourhood in subsequent years would find them in the same position.

619. In the middle of March, Mr. Stirling suddenly received orders to proceed to Mong Hsing, the capital of Keng Cheng and the rest of the Keng Tung—Keng Cheng boundary demarcation was left to Colonel Woodthorpe. He found it impossible, however, owing to the haze, to survey the country bordering on Keng Hung and Mong Lem, and operations were confined to mapping the actual routes traversed and detaching a sub-surveyor, whenever opportunity offered, to obtain new topography. Thus a small amount of new mapping was obtained and a good deal of the reconnaissance which was previously effected hastily has been considerably improved.

620. The detachment marched back by a new route to Mong Hsu and thence by Legya to Fort Stedman, which was reached on the 27th April 1894. The outturn of work of the detachment comprised 1,400 square miles of triangulation and 2,570 square miles of topography on the $\frac{1}{4}$-inch scale.

621. The main body of the party, constituting the detachment under Lieutenant Ryder, left Fort Stedman on the 13th December 1893. Lieutenant Ryder and Mr. Doran undertook the triangulation, while Messrs. Kelly and Shaw continued the topography, in sheets Nos. 5 N. E. and 5 S. E., the object being to complete, as far as possible, the first survey of the Southern Shan States. This was satisfactorily effected; the area triangulated being 7,250 square miles, and that topographically surveyed on the $\frac{1}{4}$-inch scale 7,880 square miles.

622. Surveyor Mahmud Hosein, who had been deputed to fill in a gap in the map of the Karenni country, completed the work satisfactorily, bringing in an area of 420 square miles surveyed on the $\frac{1}{4}$-inch scale.

623. The full result of the season's operations is as follows :—

Triangulation	8,650 square miles,
Topography, $\frac{1}{4}$-inch scale, ...	10,870 „

624. During the recess, all computations were completed; the mapping of sheets Nos. 5 N. E., 5 S. E., and 6 N. W. was completed and sent for publication, as well as a special map of the work done with the Keng Tung mission.

625. The recess office of the party was inspected at Bangalore in September by the Surveyor-General who was well satisfied with the results of the season's operations and with the progress that had been made in the recess work.

626. The programme for the ensuing field season is as follows :—

Colonel Woodthorpe, Lieutenant Ryder, and two native surveyors will accompany the Anglo-French Commission which is to start in November for the object of examining the contemplated neutral state on the Mekong river. One sub-surveyor will proceed to the northern boundary of the Keng Tung State, where it marches with Mong Lem and Mong Lun, to complete the survey which was

perforce left unfinished last season. The rest of the party will be employed on the survey on the 1-inch scale of the Southern Shan States, extending the triangulation over sheets Nos. 358, 359, 360 and 361, and undertaking the topography of sheets Nos. 358 and 359.*

No. 21 PARTY.

627. The party, under Captain F. B. Longe, left recess quarters at Bangalore for the field during the last week of October and first week of November 1893, and, as usual, assembled at Mandalay, where preliminary arrangements were made and squads, etc., told off to the various detachments. Captain Gordon rejoined from furlough on October 30th and proceeded with the party to Burma.

Personnel:

Captain F. B. Longe, R.E., Deputy Superintendent, 1st grade, in charge.
Capt. P. J. Gordon, S. C., Assistant Superintendent, 1st grade.
Mr. A. J. James, Extra Assistant ditto, 4th grade.
Mr. J. M. Kennedy, Sub-Assistant ditto, 1st grade.
Mr. W. F. E. Adams, ditto ditto, 2nd grade.

Surveyors and Sub-Surveyors.

Ikbaluddin, Sher Shah, Mohamed Latif, Budhi Balram, Mohamed Alum, Mohamed Nawaz, Natha Singh, and three apprentices.

628. As but little of the preliminary geographical survey of Upper Burma remained to be done, except in the extreme north of the province, where special escorts are necessary, the cost of which would be prohibitive for survey purposes only, it was arranged with the concurrence of the Burma Government to commence a topographical survey on the 1-inch scale of the Southern Shan States (an accurate survey of which is much required for administrative purposes), with such portion of the establishment as was available after providing detachments for certain special surveys that were required.

629. The programme of work that was arranged consisted of the following operations:—

(i) The survey and delimitation of the Chin-Manipur boundary, for the settlement of which a Commission had been appointed.
(ii) The completion of the geographical survey in Northern Hsinwi in the Northern Shan States.
(iii) The survey of those portions of the Konkè country to which an expedition was proceeding.
(iv) The commencement of the 1-inch topographical survey of the Shan States.

The completion of the geographical survey of the Upper Chindwin district which had also been arranged for, had to be abandoned for political reasons.

630. The distribution of the party for these operations was as follows:—

Captain Longe and Sub-Surveyor Mahomed Latif for the Chin-Manipur boundary survey.

Mr. Kennedy, Surveyor Sher Shah and Sub-Surveyor Nathu Singh for the work in Northern Hsinwi.

Surveyor Ikbaluddin to accompany the Konkè column.

Captain Gordon with the remainder of the party for the 1-inch topographical survey in the Shan States.

631. The part of the Shan States that was selected for the commencement of the topographical survey is the country about Fort Stedman, and Captain Longe proceeded there first to assist Captain Gordon in starting the 1-inch survey operations. On the 6th January 1894, he had to hasten back to Mandalay to pick up his detachment for the Boundary Commission. He proceeded from Mandalay *vid* Kindat to Tinzin in the Kabaw Valley where he met the Commissioners, Messrs. Carey and Porteous on 27th January. The field operations were commenced on 29th January and completed on 27th February under considerable climatic difficulties. A special report by Captain Longe on this work will be found in the appendix. On the completion of the boundary work, Sub-Surveyor Mahomed Latif was detailed to accompany the Manipur portion of the Commission on their return journey to Manipur, in order to map the country

* Colonel Woodthorpe reports in high terms of the work performed by sub-surveyors Ramsabad and Abdul Rahim, who accompanied him on the boundary commission.

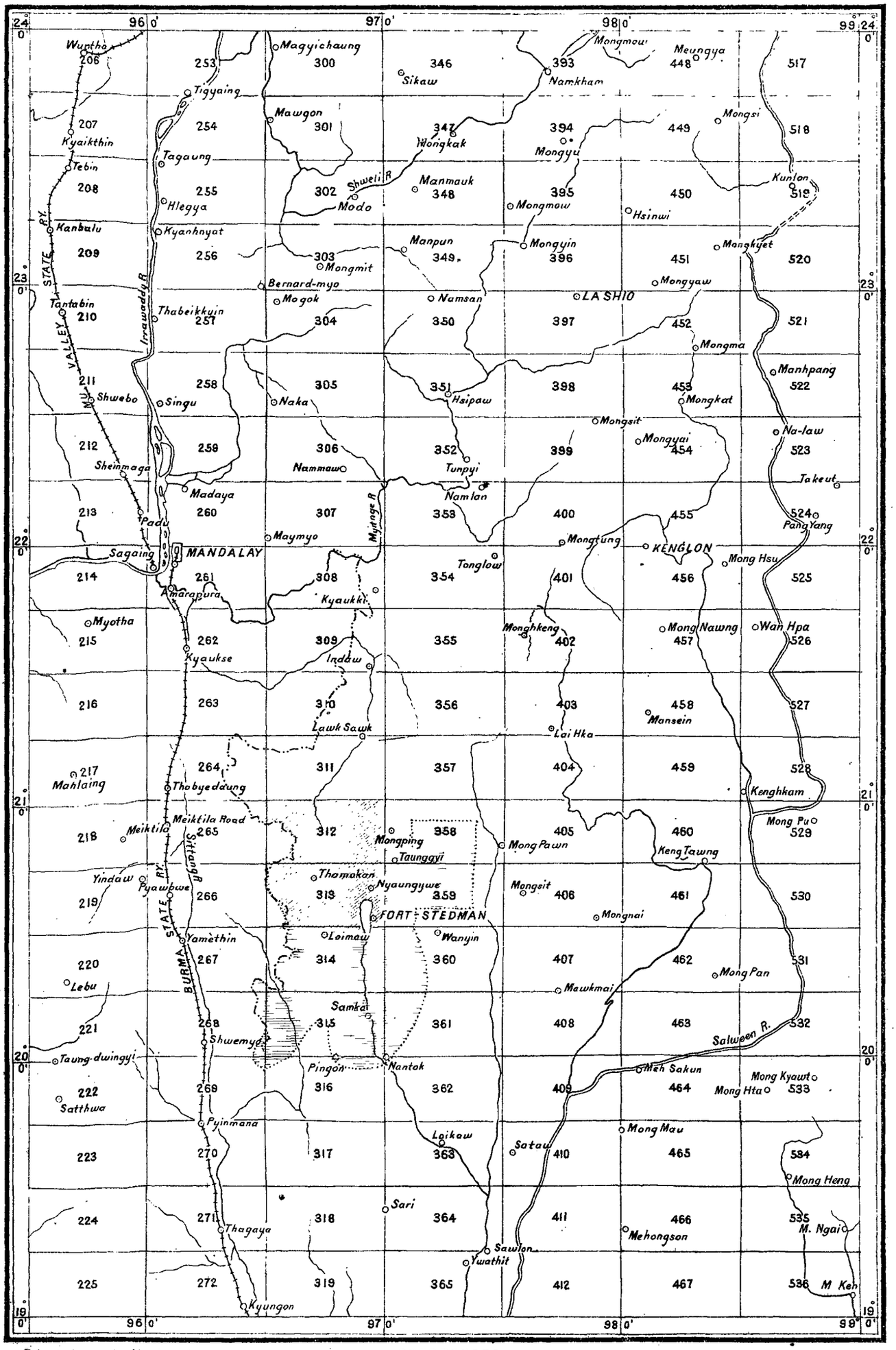
Lieutenant Ryder reports that Mr. Doran executed a large area of triangulation with great care and accuracy, and that Messrs. Kelly and Shaw also completed the work entrusted to them very satisfactorily.

Of the Native surveyors, Mahmud Hosein, J. Sebastian, Kudratullah, Mowni Ram and Sita Ram are well reported on.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA & SHAN STATES.

1893-94. No. 21 PARTY.



Reg[illegible] 1 in. = Mile. 80 = 50"

Photo., S. I. O., Calcutta

No. 359-S. 95.

NOTES.

The numerals 312, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

REFERENCES.

1" = 1 Mile

Area Surveyed in Season 1893-94.....

....Triangulated in advance.....

Scale of Miles

20 10 0 20

134662

en route, and also to survey a gap to the south-east of Manipur. This was successfully carried out and the sub-surveyor mapped in a very creditable manner an area of 1,054 square miles on the ¼-inch scale of hitherto unknown country in the hills west of the line Manipur-Tammu. The total outturn by this detachment in the Chin-Manipur hills, including the boundary work, comprised the survey of an area of 2,550 square miles, on the ¼-inch scale, of difficult and intricate country.

632. The detachment under Mr. Kennedy that was told off for the survey of the gaps in the Northern Shan States, failed to accomplish its object. On arrival at Hsinwi it was found that the country was in so disturbed a state that it was not possible to attempt survey work therein. The detachment was re-called with the concurrence of the Local Government and sent to the Southern Shan States to assist in the 1-inch topographical survey.

633. Surveyor Ikbaluddin, who accompanied the expedition to the Konkè country, surveyed an area of 1,370 square miles therein of very rugged country, on the ¼-inch scale, in the face of many difficulties.

634. The bulk of the party under Captain Gordon proceeded on 22nd November to Thamakan, which was made the head-quarters of this detachment, to prosecute the 1-inch survey in the Southern Shan States. The triangulation was commenced early in December 1893, and the detail survey was started on 7th January 1894 in sheets Nos. 311 and 312 and continued until the end of April 1894. The small detachment from the Northern Shan States joined at the end of January and assisted in the detail survey.

635. The area triangulated during the season amounted to 2,370 square miles of which 1,306 square miles are in advance for next year's detail survey.

636. The detail survey completed on the 1-inch scale embraced an area of 1,064 square miles (including overlaps) in 18 States and Sub-States of which 9 were surveyed in full and 9 in part. This outturn must be considered quite satisfactory considering that the preliminary basis of the triangulation had to be executed in the same season, which necessarily delayed the start of the detail survey, and that the men were inexperienced in surveys on this scale. The work of each surveyor and sub-surveyor was carefully checked *in situ* by Captain Gordon and Messrs. James and Kennedy, and found to be accurate.

637. Further details of these operations in the Southern Shan States together with a description of the country operated in will be found in the narrative report by Captain Gordon in the appendix.

638. The party closed field operations at the end of April 1894 and returned to Meiktila Road station, whence the recess establishment proceeded to Bangalore, and the recess office was opened at the latter place at the end of May.

639. The aggregate outturn of the party for the season is as follows:—

Triangulation	2,370	square miles.
Topographical survey, 1-inch scale . .	1,064	„
Geographical „ ¼-inch scale . .	3,920	„

640. A good deal of sickness was experienced at the commencement of the field season, chiefly on account of delay in marching through the *terai*, owing to a misinterpretation of orders, but on the whole the health of the party was good. Two menials died at Mandalay and one, an old *jemadar*, succumbed to malaria shortly after the return of the party to Bangalore.

641. During the recess, the computations have been completed and fresh editions of the following maps prepared on the ¼-inch scale:—

Sheets Nos. 15, N. E., S. E., and part of S. W.
„ „ 1. N. W., 1. N. E.

and on the scale 1-inch = 1 mile, sheet No. 312, has been completely drawn, while sheet No. 311 has been outlined and will be completed in the Calcutta Drawing Office. Reductions of all new work on the ¼-inch scale were made and forwarded to Calcutta for incorporation in the new edition of the 16-mile map of Upper Burma; a new index map was prepared and triangulation charts compiled as far as possible.

642. The spelling of the names on the maps has been very carefully checked, and it is hoped that very few errors will be found, but orthography is a

matter of great difficulty in Burma, and thanks are due to Mr. Hildebrand and Mr. Giles in the Southern Shan States, to Mr. Porteous in Manipur and to Mr. Carey in the Chin Hills for the assistance given in this work.

643. Mr. Kennedy was presented by the Chief Commissioner, Burma, during the recess season with an inscribed gold watch and chain in recognition of his good services in Burma, especially in connection with the suppression of the Kachin rising in North Hsinwi, which was mentioned in last year's report.

644. The Surveyor-General inspected the recess office of the party at Bangalore in September 1894 and was quite satisfied with the work that had been executed during the previous season. He is of opinion that Captain Longe deserves much credit for the zeal and energy he has displayed in the furtherance of the survey of Upper Burma.

645. The programme for the ensuing season is as follows:—

Captain Longe and two surveyors to complete the survey of North Hsinwi on the $\frac{1}{4}$-inch scale. One sub-surveyor to carry out survey on the $\frac{1}{4}$-inch scale in the Upper Chindwin district. One surveyor to accompany the mission for the demarcation of a certain portion of the Burma-Siam boundary in the Amherst district. The bulk of the party to continue the 1-inch survey of the Southern Shan States.*

* The following officers are especially mentioned:—Captain P. J. Gordon, to whom is mainly due the success of the first season's work on the 1-inch scale, Mr. Kennedy, Mr. James, Surveyor Ikbaluddin, and sub-surveyors Mohamed Latif, Natha Singh, and apprentice sub-surveyor Jamna Persad.

Summary of the outturn of work of th

Scale of survey.	Number of party.	Locale of field operations.		TRIANGULATION.														
				Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros.					Tertiary—in which two angles of each triangle are observed.				
									Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.
64 inches=1 mile	2 & 8	Comilla Civil Station	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7	Mergui (Tin Mines)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
32 inches=1 mile	Det.	Balasore town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Det.	Jagannath temple lands	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Det.	Garhwal	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
16 inches=1 mile	2 & 8	Gaya	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Saran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Champaran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Tippera	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Bogra	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		24-Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Hooghly	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Burdwan	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Palamau	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	3	Meiktila	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Yamethin	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Katha	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Upper Chindwin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Yeu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Shwebo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	4 & 5	Shahabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Darbhanga	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	6	Cachar	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7	Mergui	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Shwegyin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	9	Bilaspur	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Balaghat	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Chanda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Raipur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sambalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	12	Magwe	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Myingyan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Pakokku	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	17	Bombay (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Det.	Cuttack	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Balasore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Fort. Brch.	Central Provs. (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
8 inches=1 mile	10	Belgaum Cantonment	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	17	Bombay (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Det.	Aden	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
4 inches=1 mile	14	Nimar (Forests)	...	5″ & 6″	864	102	1·7	1·7	73	153	15	0·3	78	449	773	0·8	442	
	17	Bombay (Forests)	...	6″ & 7″	465	121	3·2	3·5	80	180	11	0·9	80	176	321	0·6	160	
	18	Himalayas	45	7″	568	80	...	...	65	129	20	0·5	65	233	395	1·9	215	
	19	Madras (Forests)	...	6″	2,000	188	3·4	3·4	185	475	16	0·4	34	400	765	1·5	395	
	20	Lower Burma (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Forest Branch	Punjab (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Oudh (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Upper Burma (Forests)	50	8″	522	16	5·7	7·0	15	20	8	0·5	13	77	132	1·5	62	
		Lower Burma (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Central Provs. (Forests)	...	7″ & 10″	1,428	66	6·0	6·4	57	200	6·8	0·5	57	239	395	1·1	244	
2 inches=1 mile	3	Shwebo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	10	South Maratha Country	55	8″ & 12″	3,417	178	3·3	3·3	178	656	8·1	0·20	178	1,501	3,151	0·3	1,501	
	15	Baluchistan	...	6″	240	29	1·5	1·8	25	62	5·1	0·6	25	124	234	0·02	104	
	18	Himalayas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	20	Lower Burma (Forests)	...	6″	420	10	35	35	6	10	16·6	...	10	...	...	...	...	
1 inch=1 mile	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	15	Baluchistan	60	6″	1,100	...	...	...	...	...	...	...	...	...	...	...	...	
	21	Upper Burma	...	6″	2,370	58	8·2	10·9	57	124	13·2	0·55	54	233	368	0·8	164	
	Det.	Indus River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Fort. Brch.	Punjab	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
½ inch=1 mile	15	Baluchistan	...	8″	2,500	...	...	...	...	...	...	...	...	...	...	...	...	
	Det.	Lower Yafi'i Country	65	6″	2,000	5	72	129	8	12	50	0·5	5	17	17	...	8	
¼ inch=1 mile	11	Upper Burma	...	6″	8,650	24	80	163	22	88	25	1·2	22	133	209	2·4	64	
	15	Baluchistan	...	...	19,000	...	...	...	...	...	...	...	...	...	...	...	...	
	21	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
⅛ inch=1 mile	15	Persia and Arabia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	24	Upper Burma	70	12″ (new)	1,480	18	...	...	...	...	...	...	...	...	...	...	...	
	25	India and Burma	71	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Totals	...	...	47,024	895	...	...	771	1,103	...	...	621	3,582	6,760	...	3,359	

Field Parties during the year 1893-94.

	SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.					DETAIL SURVEY.						REMARKS.
	Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical stations connected with lines of levels.	Number of other bench-marks connected.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average linear error per *mile*.	Area in square miles.	Area in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test lines.	Number of villages.	Number of fields.	Average size of field in acres.	
...	...	...	...	...	...	...	...	...	...	$3\frac{33}{64}$	...	15	16	8,682	0·27	(*a*) Revision of a previous survey.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(*b*) Includes 147 square miles of village boundary survey.
...	...	...	...	...	...	...	...	...	...	5	...	15	28	19,396	0·14	(*c*) Includes 63 square miles of revision survey on 32-inch scale.
...	...	...	...	...	...	...	...	...	...	105(*a*)	...	185	144	98,641	0·68	(*d*) Calculated on the cultivated portion only.
5	...	...	...	...	82	13	5·1	0·5	6	261	...	549	653	343,431	0·49	(*e*) Tested *in situ*.
20	...	...	...	...	10,851	2,272	...	...	481(*b*)	471(*c*)	...	2,544	590	536,497	...	
...	...	...	...	...	20,045	4,203	...	...	982	549	...	2,501	1,260	810,717	0·43	
...	...	...	...	...	37,330	6,372	...	...	1,320	517	...	1,674	325	474,679	0·70	
...	...	...	...	...	...	...	...	...	...	262	...	985	754	535,260	0·31	
...	...	...	...	...	332	40	...	...	4	42	...	175	133	41,347	0·65	
...	...	...	...	...	1,078	191	...	...	32	...	...	...	...	...	...	
...	...	...	...	...	436	66	...	...	10	36	...	131	85	57,583	0·41	
10	...	...	...	...	474	78	...	...	12	9	...	23	26	23,141	0·26	
...	...	...	...	...	10,475	1,784	...	...	280	131	...	441	210	95,000	0·88	
...	...	...	...	...	13,271	2,188	2·5	0·4	728	820	...	703	1,016	427,095	1·23	
...	...	...	...	...	6,801	924	3·5	0·45	350	132	...	...	...	106,226	0·80	
...	...	...	...	...	9,478	1,150	9	0·81	393	226	...	...	98	203,019	0·71	
15	...	...	...	...	1,974	372	5	...	103	103	...	...	92	118,087	0·56	
...	...	...	...	...	...	...	...	...	...	630	...	552	216	402,465	1·00	
...	...	...	...	...	...	...	...	...	...	47	...	...	4	3,102	9·70	
...	...	...	...	...	473	50	...	...	28	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	979	...	3,745	1,594	1,375,509	0·46	
...	...	...	...	...	10,107	2,040	...	...	518	...	...	...	...	...	...	
...	...	...	...	...	11,746	1,262	5	0·9	360	150	...	388	159	69,721	1·38	
25	...	...	...	...	3,841	460	4	0·4	108	123	...	136	131	31,462	0·58(*d*)	
...	...	...	...	...	23,408	3,147	6	0·6	962	679	...	1,433	387	295,835	0·41(*d*)	
...	...	...	...	...	...	...	...	...	...	79	...		67	38,638		
...	...	...	...	...	25,553	4,047	3	0·3	1,500	...	...	...	...	...	...	
...	...	...	...	...	1,404	108	6	0·44	96	...	...	...	...	...	...	
30	...	...	...	...	22,126	3,500	6	0·44	956	...	...	...	...	...	...	
...	...	...	...	...	253	34	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	21,570	3,793	4	0·76	845	...	...	...	...	...	...	
...	...	...	...	...	28,285	4,797	5	0·57	1,589	1,250	...	2,664	1,015	486,000	1·64	
...	...	...	...	...	3,887	878	3	0·50	200	...	...		...	...	...	
35	...	...	...	...	263	13,400	6	0·42	26	26	...		29	11,040	1·51	
...	...	...	...	...	...	...	...	...	...	65	...	85	...	...	...	
...	...	...	...	...	682	138	...	...	15	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	644	...	2,117	1,539	713,353	0·58	
...	...	...	...	...	...	...	...	...	...	111	131	(*e*)	...	...	...	
40	...	...	...	...	499	120	4·9	0·39	...	22	28	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	222	200	185	...	...	...	
...	...	...	...	...	...	...	...	...	...	17	...	(*e*)	...	...	...	
...	...	...	...	...	5,809	867	7	1·6	...	565	73	316	...	...	...	
...	...	...	...	...	724	215	0·5	0·3	...	202	114	(*e*)	...	...	...	
45	...	...	...	...	...	...	...	...	...	540	44	(*e*)	...	...	...	
...	...	...	...	...	...	620	...	...	...	881	53	...	...	...	...	
...	...	...	...	...	13,316	686	9	0·6	420	282	170	134	...	...	...	
...	...	...	...	...	...	...	...	...	...	123	49	(*e*)	...	...	...	
...	...	...	...	...	1,853	240	7	4·8	...	356	78	78	...	...	...	
50	...	...	...	...	4,951	112	7	3·3	...	134	194	60	...	...	...	
...	...	...	...	...	...	...	...	...	...	112	136	2	...	...	...	
...	...	...	...	...	...	...	...	...	...	597	162	(*e*)	...	...	...	
...	...	...	...	...	...	...	...	...	...	183	...	(*e*)	...	...	...	
...	...	...	...	...	...	...	...	...	...	70	...	(*e*)	...	...	...	
55	...	...	...	...	...	...	...	...	...	3,768	17·5	511	...	...	...	
...	...	...	...	...	...	...	...	...	...	226	26	91	...	...	...	
...	...	...	...	...	...	...	...	...	...	305	26	(*e*)	...	...	...	
...	...	...	...	...	...	...	...	...	...	144	170	44	...	...	...	
...	...	...	...	...	...	...	...	...	...	151	...	...	...	...	...	
60	...	...	...	...	...	...	...	...	...	600	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	1,183	...	...	...	...	...	
...	...	...	...	...	4,636	1,568	1·5	0·30	1,061	1,219	7	95	199	...	...	
...	...	...	...	...	...	...	...	...	...	287	7	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	5,862	...	...	...	...	...	
65	...	...	...	...	...	...	...	...	...	1,800	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	10,870	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	8,290	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	3,920	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	76,090	...	...	...	...	...	
70	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Trigonometrical operations only.
71	386	38	3	374	...	...	...	...	...	...	...	...	...	...	...	
...	386	38	3	374	298,013	61,735	...	...	13,385	$127,477\frac{1}{4}$	...	22,577	10,770	7,325,926	...	

Statement showing the cost-rates of work executed by th

Number of party.	Nature and *locale* of field operations.		Cost-rate per square mile in rupees.							
			Triangulation.	Traversing.	Detail survey and preparation of maps on scales of						
					½″	1″	2″	4″	8″	16″	32″
	Topographical Surveys.										
10	South Maratha Country	1	5·8	3·9(*a*)	...	...	12·2	...	43·0	...	...
15	Baluchistan	...	8·5	...	7·5	12·0	20·8	...	...	...	...
18	Himalayas	....	9·7	...	...	...	...	...	...	...	...
21	Burma	...	5·2	...	...	20·0	42·9	82·6	...	...	...
Det.	Indus River	5	...	14·7	...	7·7	...	...	...	...	...
	Forest Surveys.										
14	Nimar	...	17·7	17·8(*a*)	...	...	...	89·0	...	...	...
17	Bombay	...	10·8	12·6	...	...	...	84·8	156·4	179·5	...
19	Madras	...	11·3		...	...	...	61·4	...	...	...
20	Lower Burma	...	36·9	133·9	...	...	87·0	159·3	...	...	...
Forest Survey Branch.	Bashahr (Punjab)	10	...	...	...	19·3	...	50·2	...	...	...
	Narsinghpur	...	...	...	...	...	...	54·7	...	...	...
	Raipur	...	...	16·7(*g*)	...	...	...	65·7	...	...	...
	Balaghat	...	6·8	...	...	...	...	40·1	...	...	...
	Nagpur, Seoni and Chhindwara	...	5·4	...	...	...	...	56·0	...	...	...
	Oudh	15	...	12·5(*i*)	...	...	...	13·5	...	...	...
	Tenasserim	...	...	...	...	...	...	83·3	...	...	...
	Pyinmana	...	12·9	10·5	...	...	...	79·8	...	...	...
	Cadastral Surveys.										
	Gaya	...	...	41·8	...	...	...	...	...	85·7	...
	Saran	...	...	32·5	...	...	...	...	...	70·4	...
	Champaran	20	...	33·3	...	...	...	...	...	74·9	...
2 & 8	Tippera	...	...	...	...	...	...	...	...	151·0	...
	Bogra	...	...	...	...	...	...	...	...	104·1	...
	Hooghly	...	...	...	...	...	...	...	...	133·2	...
	Burdwan	...	...	68·6	...	...	...	...	...	156·5	...
	Palamau	25	...	21·6	...	...	...	...	...	94·4	...
	Yeu	...	...	...	...	...	...	...	...	107·2	...
	Shwebo	...	...	...	...	...	...	...	...	108·7	...
	Katha	...	...	56·5	...	...	...	...	...	86·3	...
3	Meiktila	...	...	65·1	...	...	...	...	...	86·6	...
	Yamethin	30	...	16·6	...	...	...	...	...	91·0	...
	Upper Chindwin	...	...	27·7	...	...	...	...	...	120·3	...
4 & 5	Muzaffarpur	...	...	...	...	...	...	...	...	68·4	...
	Darbhanga	...	...	27·9	...	...	...	...	...	...	...
6	Cachar	...	...	54·5	...	...	...	...	...	78·1	...
	Amherst	35	...	61·4	...	...	...	...	...	126·3	...
7	Shwegyin	...	...	...	...	...	...	...	...	156·0	...
	Mergui	...	...	177·4	...	...	...	...	...	98·3	...
12	Magwe and Pakokku	...	...	45·5	...	...	...	...	...	95·0	...
	Myingyan	...	...	38·0	...	...	...	...	...	...	...
Det.	Garhwal	40	...	30·3	...	...	...	...	...	...	180·9
Det.	Cuttack	...	...	24·3	...	...	...	...	...	...	...
	Balasore	...	...	...	...	...	...	...	...	75·2	...
	Traverse Surveys.										
9	Central Provinces	43	...	23·8	...	...	...	...	...	...	...

several Field Parties during the year 1893-94.

	Cost-rate for traversing, detail survey and preparation of maps.	Cost-rates.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
		Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.		
	Per acre.	Per square mile.	Per square mile.	Per square mile.		
	a. p.	₹	₹	₹	₹	
1	...	...	...	...	75,896(*b*)	(*a*) Rate calculated per linear mile.
...	...	...	...	...	1,30,659(*c*)	(*b*) Includes ₹9,021 expended on Gujarat Survey General Degree reports.
...	...	...	...	...	70,635(*d*)	(*c*) Includes ₹36,000 expended on ¼-inch and ⅛-inch geographical surveys; and ₹6,400 on traversing for 16-inch settlement survey.
...	...	...	...	...	80,471(*e*)	(*d*) Includes ₹12,918 expended on special forest survey of the Simla Hill States; ₹331 on Kalka town survey; ₹1,027 on instruction of soldier surveyors; ₹1,688 on survey schools; and ₹7,466 on arrears of mapping.
5	...	...	...	...	25,067	(*e*) Includes ₹46,827 expended on ¼-inch geographical surveys.
						(*f*) Includes ₹5,653 expended on the classification of forest and soils of 565 square miles; ₹5,379 on arrears of mapping and computations for the past survey year, and ₹1,136 on instruction of soldier-surveyors.
...	...	...	...	...	97,095(*f*)	(*g*) This rate is for levelling per linear mile.
...	...	...	...	...	71,800	(*h*) Includes ₹4,833 expended on printing and publishing of cyanotype and photo-zinco. maps, etc. of the Chanda, Jabalpur, and Bhandara divisions, and ₹176 on computations and plotting in advance of field operations for Saugor division.
...	...	...	...	...	78,549	(*i*) This includes a rate of 8·4 for levelling per linear mile.
...	...	...	...	...	1,29,198	(*j*) Includes ₹4,500 expended on two elephants, and ₹870 on publishing charges for maps of the Pilibhit forests.
10	...	...	...	...	11,742	(*k*) Includes ₹3,777 expended on revision survey with records; ₹1,589 on village boundary survey of 147 square miles of *mukarrari* villages.
...	...	...	..	...	}	(*l*) Includes ₹1,547 expended on traversing and revision of traversing.
...	...	...	...	...	52,285(*h*)	(*m*) Includes ₹4,275 expended on arrears of previous season's work; ₹3,863 on 4-inch skeleton mapping, and ₹86 on demarcation.
...	...	...	...	..	}	(*n*) The rate includes cost of traversing of 1892-93.
...	...	...	...	...		(*o*) Includes ₹6,260 expended in embedding cylinders in Kyaukse district, and ₹383 on Katha gold fields survey.
15	...	..	...	...	13,167(*j*)	(*p*) Includes ₹2,000 expended on 4-inch and 2-inch mapping.
...	...	...	...	...	}	(*q*) Includes ₹6,805 expended on arrears of traverse computations.
...	...	...	...	...	29,095	(*r*) Includes ₹6,264 expended on demarcation; ₹11,693 on 2-inch mapping, completion of records and *kanungo* circle maps of Assam Valley; ₹9,956 on revision survey and completion of records of Jaintiah *parganas*, Sylhet, and ₹2,299 on instruction of officers and local men.
...	3 2	0·9	45·3	15·6	73,517(*k*)	(*s*) Includes ₹1,906 expended on 2-inch mapping; ₹5,251 on demarcation; and ₹6,589 on topographical survey of 221 square miles.
...	2 7	4·2	36·0	13·8	99,473	(*t*) Includes ₹4,368 expended on the 64-inch survey of tin mines.
20	2 8	5·0	29·6	25·0	1,21,992	(*u*) Includes ₹712 expended on skeleton plots of Lalitpur; ₹638 on despatching of instruments to Lalitpur; ₹670 on triangulation, etc., in Naini Tal; ₹326 on revision survey in Naini Tal, and ₹581 on instruction of *patwaris* in district Meerut.
...	3 9	...	67·9	34·6	78,309	(*v*) Includes ₹32,568 expended in bringing up 16-inch, 32-inch and 64-inch arrears work of previous seasons, and ₹374 on relaying Dhenkanal boundary.
...	2 7	...	18·9	15·2	7,149	(*w*) Includes ₹842 expended on arrears of traverse computations; ₹24,196 on completion of records, traces, etc., of previous season's; and ₹1,120 on the Balasore town survey.
...	3 4	...	31·9	...	8,224(*l*)	
...	5 8	...	78·4	...	10,973(*m*)	
25	2 11	2·0	44·9	28·8	27,037	
...	3 9(*n*)	...	...	...	67,562	
...	3 9(*n*)	...	...	...	9,051	
...	3 7	6·6	...	...	50,967(*o*)	
...	3 10	7·8	...	...	1,24,083(*p*)	
30	2 8	3·2	...	...	18,925	
...	3 8	8·3	...	...	16,096	
...	1 8	...	52·3	25·8	1,33,850(*q*)	
...	...	3·6	...	...	16,340	
...	3 4	...	...	51·3	69,270(*r*)	
35	4 8	...	...	...	1,58,521(*s*)	
...	3 11	...	...	...	12,324	
...	6 10	...	...	...	35,440(*t*)	
...	3 6	4·8	...	15·7	2,22,793	
...	...	4·2	...	...	8,443	
40	5 3	...	...	...	51,808(*u*)	
...	...	25·3	...	...	33,740(*v*)	
...	11	...	23·2	46·8	96,465(*w*)	
43	...	2·2	...	...	91,924	

Particulars of Cadastral Surveys completed in 1893-94.

District.	Scale of survey.	Number of villages.	Number of fields.	Area surveyed.	Average size of fields.	Cost, exclusive of demarcation and charge for instruments.	Rate per square mile.			By whom and when surveyed.
							Traverse Survey.	Cadastral Survey.	Cadastral Survey with Record of Rights.	
				sq. miles	acres	₹	₹ a. p.	₹ a. p.	₹ a. p.	
Garhwal	32″=1 mile	4,401	2,877,305	952	0·22	3,16,070	35 4 11	...	268 1 7	Lieut.-Col. J. E. Sandeman and Mr. T. F. Freeman, during 1889—94.
Mergui	16″=1 mile	632	150,766	391	0·64	1,19,239	136 10 0	120 14 6	...	Mr. C. Wood, during 1891—94.
Minbu	16″=1 mile	492	638,199	1,249	1·25	2,58,666	58 1 7	145 6 8	...	Mr. W. H. Patterson, during 1892—94.

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

646. These offices comprise—

(1) The Head-quarters offices at Calcutta.
(2) The Trigonometrical Branch office at Dehra Dun.
(3) The Drawing Office at Simla.
(4) The Forest Survey Branch office at Dehra Dun.

A detailed description of the work carried on in each office is given below :—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Colonel H. R. Thuillier, C.I.E., R.E., Surveyor-General of India.
Lieutenant-Colonel C. Strahan, R.E., Deputy Surveyor-General, in charge Revenue Branch up to 3rd July 1894.
Colonel W. H. Wilkins, S.C., Officiating Deputy Surveyor-General, in charge Revenue Branch from 4th July 1894.
Colonel J. E. Sandeman, S.C., Director of Bengal Surveys up to 7th August 1894.
Colonel M. W. Rogers, R.E., Assistant Surveyor-General from 18th October 1893.
Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, up to 17th October 1893.
Mr. T. Archdale Pope, Deputy Superintendent, 2nd grade, Personal Assistant to the Surveyor-General from 1st November 1893 up to 30th April 1894.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. T. A. Milne, Head Assistant.
Mr. G. C. Walker, Head Clerk.
Babu Kali Podo Banerji, Clerk.
Babu Bani Madhub Banerji, Clerk.
Babu Chuni Lal Dey, „
Babu Durga Narayan Ghose, „
Babu Ramkristo Chunder, „
Mr. H. E. D'Cruz „
Babu Gopal Chunder Dass, „
Babu Kali Kristo Chunder, „
and 9 others.

Accounts.

Mr. C. O. Gray, Head Clerk.
„ T. E. Ware, Clerk, up to 21st August 1894 (deceased).
Babu Rajkrishna Mukerji, Clerk,
Mr. E. A. Bonnaud, „
Babu Hem Nath Dutt, „
and 7 others.

647. The general direction of these offices remained in the hands of Colonel H. R. Thuillier, C. I. E., R. E., throughout the year. The Revenue Branch section continued under the superintendence of Colonel C. Strahan, R.E., except during his absence on privilege leave, when Colonel W. H. Wilkins, S.C., officiated as Deputy Surveyor-General. The General and Topographical Branch sections were under Colonel M. W. Rogers, R.E., except for a short period when Colonel W. H. Wilkins held charge. Mr. T. A. Pope held the office of Personal Assistant to the Surveyor-General.

The Bengal surveys were under the direction of Colonel J. E. Sandeman, S.C., except during his absence on privilege leave, when the Deputy Surveyor-General in charge Revenue Branch conducted the duties of the office.*

* The Assistant Surveyor-General reports as follows :—

The general superintendence of the office has been carried on satisfactorily by Mr. T. W. Babonau, the Registrar. Messrs. Milne and Gray have also done well in their respective posts. Mr. J. A. Vallis has again satisfactorily arranged for the despatch of the survey *khatásis* to Burma.

The clerks have also worked well, and the following are deserving of special mention :—Babus Bani Madhub Banerji, Chuni Lal Dey, Raj Krishna Mukerji, Kanti Chunder Sen and Mohendra Chunder Aich.

The Deputy Surveyor-General reports that in the Revenue Branch office, Babus Kali Podo Banerji, Ram Kristo Chunder and Nobendro Nath are deserving of special mention.

DRAWING OFFICE.

648. The Drawing Office remained in the charge of Colonel W. H. Wilkins, S. C., throughout the year, except for a period of about 3 months from 3rd July 1894, when it was under the superintendence of Mr. B. G. Gilbert-Cooper.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge up to 3rd July 1894.
Mr. B. G. Gilbert-Cooper, Assistant Superintendent, 1st grade, in charge from 4th July 1894.
Mr. S. M. Smylie, Chief Draftsman up to 31st March 1894.
Mr. L. J. Pocock, Chief Draftsman, from 1st April 1894.
Mr. A. G. Wyatt, Officiating Head Draftsman, from 1st April 1894 to 5th July 1894.
Mr. W. Stotesbury, Head Draftsman, from 6th July 1894.
Mr. J. A. Higgs, Draftsman, from 1st November 1893.
Mr. W. Green, Draftsman.
Mr. A. J. Musgrove, „
Mr. J. R. Adels, „
Mr. R. C. Sinclair, „
Mr. A. S. Bateman, „
Mr. A. J. J. Rodrigues, „
Mr. N. G. Watson, „
Mr. A. Wilson, „

Native Draftsmen.

Babu Mohesh Chandra Shaw.
Munshi Muttiullah.
Babu Purna Chandra Sen.
Babu Gopal Chandra Roy.
Munshi Abdul Aziz.
Babu Tin Cowry Sen.
Munshi Rahim Bakhsh.
Munshi Abdul Razak.
Babu Becharam Banerjee.
Babu Ram Chandra Sen.
Babu Sarat Chandra Chatterji.
Mr. R. G. Gomes.
Munshi Nur Bakhsh.
Babu N. N. Mukerji.
„ S. C. Sirkar, and 44 others.

Additional Establishment.

Mr. A. J. James, Draftsman, up to 1st November 1893.
Mr. G. D. Cusson, Draftsman, from 1st November 1893.
7 Native draftsmen.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. A. G. Wyatt, Extra Assistant Superintendent, 2nd grade.
Mr. J. A. Barker, Extra Assistant Superintendent, 4th grade.
Mr. G. D. Cusson, Extra Assistant Superintendent, 6th grade, up to 31st October 1893.
Mr. W. C. G. Barckley, Extra Assistant Superintendent, 6th grade, from 27th October 1893.
Mr. C. W. F. Seyers, Extra Assistant Superintendent, 6th grade, up to 17th April 1894.
Mr. S. O. Madras, Extra Assistant Superintendent, 5th grade, from 7th August 1894.
Mr. W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade, from 27th November 1893.
Mr. T. J. J. Mills, Sub-Assistant Superintendent, 1st grade, from 1st December 1893.
Mr. T. W Babonau, Jr., Sub-Assistant Superintendent, 2nd grade.

649. Mr. S. M. Smylie held the post of Chief Draftsman up to 31st March 1894, when he proceeded on furlough preparatory to retiring from the service. He was succeeded by Mr. L. J. Pocock from the 1st April 1894.

650. The organisation of the Drawing Office has remained as hitherto, being divided into three sections, *viz.*, the Geographical, Revenue and Cadastral, which are reported on separately, and a detailed statement of work completed in each section is given in the appendix.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

651. The preparation of maps of Burma on various scales has been the principal work of this section. On the quarter-inch scale, sheets Nos. 15 N. W. and 15 S. W. of the North-East Frontier series, and sheets Nos. 2 N. W. and 2 S. W. of the South-East Frontier series, mentioned in the last Annual Report as in progress, are now well advanced and nearly ready for the press. Of sheets Nos. 22 and 23 of the North-East Frontier series on the 8-mile scale, the former has gone through a further fresh edition, with material supplied by the Quarter Master General's Department, and the latter is nearly ready for press.

652. A new edition of sheet No. 3A., of the South-East Frontier series on the 8-mile scale, has been prepared and completed from the one-inch maps of Lower Burma, and of sheets Nos. 1, 4, 5 and 6 of the same series, which were in progress during the previous year, sheet No. 1 has been published, while the other three are well advanced. New compilations of sheets Nos. 10 and 13, on the same scale, were commenced during the year, with the view of completing the 8-mile series of maps as soon as material for them becomes available.

653. A second edition of the 16-mile map of Upper Burma, prepared for publication in two colours, has been in progress during the year, and there is every reason to believe that it will be published before this report issues from the press. It comprises a greater tract of country than the first edition, the limiting meridians being 93° and 102° east longitude. This map has been compiled from all available material up to date, and contains the most recent geographical information. The Quarter Master General's Department has supplied much valuable material for the compilation of the portion of the map east of the Mekong river.

654. The compilations of the provincial maps of the Bombay and Madras Presidencies, mentioned in paragraph 559 of the last Annual Report, having been completed in this section, were made over to the Engraving Office for engraving on copper, where they are now in progress.

655. The 32-mile map of India, third edition, has been brought up to date during the year. The geography of the North-Eastern Frontier has been much changed, but as was the case last year its completion and publication still awaits the orders of the Government of India regarding the frontier boundaries that are to be inserted.

656. In addition to the current departmental work, there has been a very large amount of miscellaneous work undertaken by this section of the office for other departments, the principal work being new editions of the maps for the Statistical Atlas of India, which is now being revised by the Revenue and Agricultural Department. Nine large statistical maps of India, on the 32-mile scale were also prepared during the year under report and sent to the Antwerp Exhibition.

657. A large amount of miscellaneous work has been also done, including many administration report maps; the reduction of record plans from the Public Works Department containing the most recent public works, such as railways, roads, and canals; and the incorporation of sketches and reconnaissances of Burma, from the Quarter Master General's Department, into the various maps of that province.

SECTION II.—REVENUE.

658. The work of this section consists in examining and preparing for photo-zincography the fair maps received from the field parties of the Revenue Branch, in bringing up to date and republishing the old maps and in supplying data.

659. Seven standard sheets of the North-Western Provinces, on the 1-inch scale, have been filled up to margin from the latest survey materials of the Rampur State and the Naini Tal (late Tarai and Kumaun) district for a second edition, as well as one sheet of Bengal of the Hazaribagh district.

660. Corrections have been made in the spelling of names and details of eleven 1-inch scale standard sheets of the Bareilly and Pilibhit districts, North-Western Provinces, for reprinting. All boundaries and a portion of the names in eight 2-inch sheets (each comprising four sections) of Bombay, have been corrected for a new issue on the 1-inch scale.

661. Nine standard sheets on the 1-inch scale, district Mergui, Lower Burma (two of which were drawn in this section), have been completed and typed for reproduction by photography to full scale.

662. A map of the city of Mooltan, with country six miles round, has been compiled on the 4-inch scale and plotted in six sheets, imperial foolscap size, from the old single village plans of the survey of 1856-7, as a guide for the new survey of that city which is being undertaken by No. 15 Party for the military authorities. The map of the Lansdowne forests in district Garhwal, North-Western Provinces, in two sheets, scale 4 inches = 1 mile, has been completed and published.

663. The map of Panchanogram, in the suburbs of Calcutta, has been brought up to date by insertion of new roads and buildings, etc., and has been drawn in ten sheets, on the scales of 4 inches and 6 inches to a mile, for reduction by photography to the scale of 3 inches to 1 mile, and for incorporation with the map of the city and suburbs of Calcutta, which has also been retyped and corrected for photo-zincography.

664. Besides the regular work, a considerable amount of mapping has been done as usual for other departments. Manœuvre maps of Rawalpindi in the Punjab, of Lucknow in Oudh, and of Muttra in the North-Western Provinces, including the country around, have been prepared and published for the military authorities. A map of Killa Kanika, districts Balasore and Cuttack in Bengal, has been drawn and published on the scale of 1 inch = 2 miles for the Settlement Officer; as well as a *kwin* map of Myoungma township in district Bassein, Lower Burma, for the Director of Land Records.

665. Of the ½-inch scale district maps in the North-Western Provinces, the map of Gorakhpur has been published; those of Mirzapur and Garhwal have been completed and are under publication; the drawing of the map of district Almora is well advanced, and that of the district of Naini Tal has been commenced.

666. The traverse computations of the field parties working in the districts of Chanda (N. W. Provinces), Thongwa (Lower Burma), and in the Rampur State have been examined. A large amount of work in calculating areas and furnishing numerical data has been done for field parties and district officers, etc. The areas of 16 sheets were calculated from the maps themselves, and the areas of district Chanda calculated and divided under the sub-heads *of malguzári*, forest and *zamindári*. The areas of district Shahpur in the Punjab were revised according to *tahsils* as now defined.

The amount of correspondence dealt with has greatly increased, 1,300 letters having passed through this section, half of which required an answer.

SECTION III.—CADASTRAL.

667. This section is employed in preparing the original maps of all the cadastral surveys for zincography and photo-zincography. The procedure is to examine the numbering of the fields and to observe if all holdings and divisions of land are correctly tabulated in the area statements.

668. The return for the previous year showed that the cadastral maps of all the districts of the North-Western Provinces entered therein, except Jhansi, had been published, and that there were 782 sheets of this district left for publication. Of these the proofs of 780 have been passed and sent to press during the year under report; the remaining two sheets are held in abeyance, pending certain corrections on them, to be made by the Settlement Officer of the district.

669. The return in last Annual Report showed that there were 1,838 sheets of Burma for publication in the office. To these were added from time to time during the year, 3,823 sheets, making altogether 5,661 sheets. Of these 3,245 have been published, against 1,578 in the previous year, or rather more than double the number.

670. At the end of the previous year there were 475 sheets of Assam remaining to be published; and since then 490 more have been received, making in all 965 sheets. Of these, 788 sheets have been published, 102 are at press, and the remainder are not intended for publication at present.

671. The original maps have been arranged and bound into 75 volumes for record in this office; and 132 volumes of printed cadastral maps of districts Amherst, Tavoy, and Mergui in Lower Burma, and Mandalay in Upper Burma, have been arranged in circles and townships for despatch to the Chief Commissioner of Burma.

672. The total number of maps passed for publication, during the year was 4,856 sheets, of which 4,810 sheets were actually printed, 3,492 having been photo-zincographed and 1,318 zincographed. Of the printed maps, 3,245 sheets were coloured, and after examination sent for record in the Map Record and Issue Office. At the close of the year there were 2,598 sheets for publication against 3,095 in last year showing a decrease of 497 sheets.*

BENGAL PROVINCIAL DRAWING OFFICE.

673. This office has been organized under the orders of the Government of Bengal, with the sanction of the Government of India, to undertake the preparation of new geographical maps of Bihar, from the results of the cadastral surveys that are in progress there. The new office, which is under the Director of Bengal Surveys, is attached to the head-quarters at Calcutta, and has been placed under the direct charge of

Personnel.

Captain J. M. Fleming, S. C., Deputy Superintendent, 2nd grade, in charge.
Mr. W. J. O. Sullivan, Extra Assistant Superintendent, 3rd grade, up to 17th May 1894.
Mr. T. Shaw, Extra Assistant Superintendent, 6th grade.
Mr. P. A. Peters, Extra Assistant Superintendent, 6th grade.
Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade, up to 18th July 1894.
Nine native draftsmen.

* Colonel Wilkins reports as follows on his Assistants :—Mr. Pocock and Mr. Stotesbury, in their posts as Chief and Head Draftsman respectively, supervised their establishments most efficiently. Messrs. Cusson and Barker have also done very well as heads of the cadastral and examining sections. Messrs. Barckley, Higgs, and Mills have also done useful work. The European draftsmen have been well reported on, and of the Native establishments, Babu Mohesh Chandra and Munshi Nur Bux, amongst others, have rendered good service.

Captain J. M. Fleming, S. C., assisted by officers of the Bengal Surveys when their services were available from field duties in connection with the various petty field surveys in the province. The procedure consists in compiling standard maps on the 2-inch scale for reduction by photography and publication on the 1-inch scale, and the maps that have been dealt with are those of Jalpaiguri, Orissa and Bihar.

674. The standard maps of the Jalpaiguri district, Western Duars, are in 36 quarter sections to form 9 sheets on the 1-inch scale. The mapping of the results of the recent cadastral survey of the district was done chiefly in the office of the field party, but their completion and examination has been proceeding in the Bengal Drawing Office, and this work has occupied much of the time of Captain Fleming's small establishment.

Large gaps were left in the survey of the district, of which a tea-grant survey under the revenue authorities had been executed some years previously. One hundred and fifty-seven maps of these tea grants, on the scale of 8 inches =1 mile, have been received and reduced to the 2-inch scale. The last large batch of these maps was only recently received. Half a dozen are still missing, and there are as many blanks in the standard maps.

It was reported in paragraph 287 of the last Annual Report that the topography of the "tea land survey" maps could not be fitted in on account of the inaccuracies of the survey. It was found that the reductions from the Deputy Commissioner's congregated maps could not be satisfactorily adjusted by any means into the gaps on the standard sheets; a system has therefore been adopted which has been successful to a certain extent.

Ten or twelve of the maps have been treated as a block, of which the compass traverse data have been set up and mathematically proved as a polygon, and in most cases these proved sufficiently well. When such a block would not close within reasonable limits, a re-arrangement of groups was made, and thus in time within each large gap, these small traverse circuits were plotted. The individual tea-grant reductions were then fitted in within these limits, and by judicious squeezing and expanding were put in relative position. This has enabled the office to utilise many of the main topographical features.

During the year under report, the drawing of 24 of the 36 quarter sections has been completed, and the whole series was finally examined and made ready for publication.

675. The survey of the Orissa division is mapped in 67 quarter sections, of which the graticules were all projected in the office of the survey party. These maps were transferred to the Bengal Drawing Office in July 1894, in all stages of progress, and the Puri sheets only have been completed in mapping. Their examination has been carried on as examiners became available.

A special publication of the maps of the irrigated area on the 2-inch scale was sanctioned by the Government of Bengal in July 1893, the cost to be debited to the Orissa Canals revenue account.

676. Not much progress has been made so far with the Bihar standard mapping, owing to the establishment having been engaged on the Jalpaiguri sheets, but now that these are nearly out of hand, it will in future be more rapid. Progress was also retarded because materials were supplied so sparingly by the field party, but this was unavoidable. The cadastral sheets which have been reduced and transferred to the 2-inch sheets are 408 in number. The typing and drawing of these is in progress.

677. The following tabular statement contains all information as to the state of the provincial mapping to date:—

Locality.	Projected.	Plotted.	Pentagraphed.	Typed.	Drawing completed.	Foot-notes, etc.	Finally examined.	Remarks.
Jalpaiguri . .	36	36	36	36	36	36	36	* Only partially completed. † Details of tea grants entered on ten sheets.
Orissa, previously completed . .	42	42	35	33	13	...	Nil	
Completed during 1893-94 . .	14	14	11	5	25	15	9	
Bihar . .	14	11	4*	2*	2†	Nil	Nil	

678. The Drawing Office was inspected by the Director, Bengal Surveys, at the end of April 1894. who also visited it from time to time when passing through Calcutta At present the draftsmen are not very experienced. It takes time to organize such an office, and it can therefore only gradually become efficient.

ENGRAVING OFFICE.

679. The superintendence of this office was held by Colonel W. H. Wilkins, S.C., until the 3rd July 1894, when Mr. Gilbert-Cooper assumed charge, and held it during the remainder of the year.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor General, in charge up to 3rd July 1894.
Mr. B. G. Gilbert-Cooper, Assistant Superintendent, 1st grade, in charge from 4th July 1894.
Mr. J. Fulford, Head Engraver.
„ W. Donaldson, Engraver.
„ S. M. Coard, „
„ T. B. Rodger, „
„ A. W. N. James, „
„ A. R. Coard, „
„ E C. V. Ollenbach, „
„ E. Earle, „
„ L. H. Musgrove, „
„ F. R. C. Scallan, „
„ W. M. Wells, „ up to 4th March 1894.
„ A. T. Vieux, Engraver.
„ A. E. Cann, „
22 Native engravers.
2 Apprentices.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer.
„ A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.

680. The outturn of work, of which a summary is given in the appendix, is about the same as last year, but the number of plates worked on is slightly less.

681. Eight new quarter-sheets of the Atlas of India have been completed and published and 40 others have been in progress, while corrections and additions have been made to 37 old plates. Eight district maps for administration reports have been completed, and 65 more are in various stages of progress.

682. Of the general maps, the skeleton edition of the 32-mile map of India, in six plates, has been corrected as far as possible to date; and the 128-mile map is still in progress. The 256-mile map of India, without hills, has been completed and published. The plate of the 96-mile railway map of India with the railways cut in thin lines has been nearly completed: transfers from this plate will be found useful in the Photo-litho. Office as a guide for printing the railway map in colours.

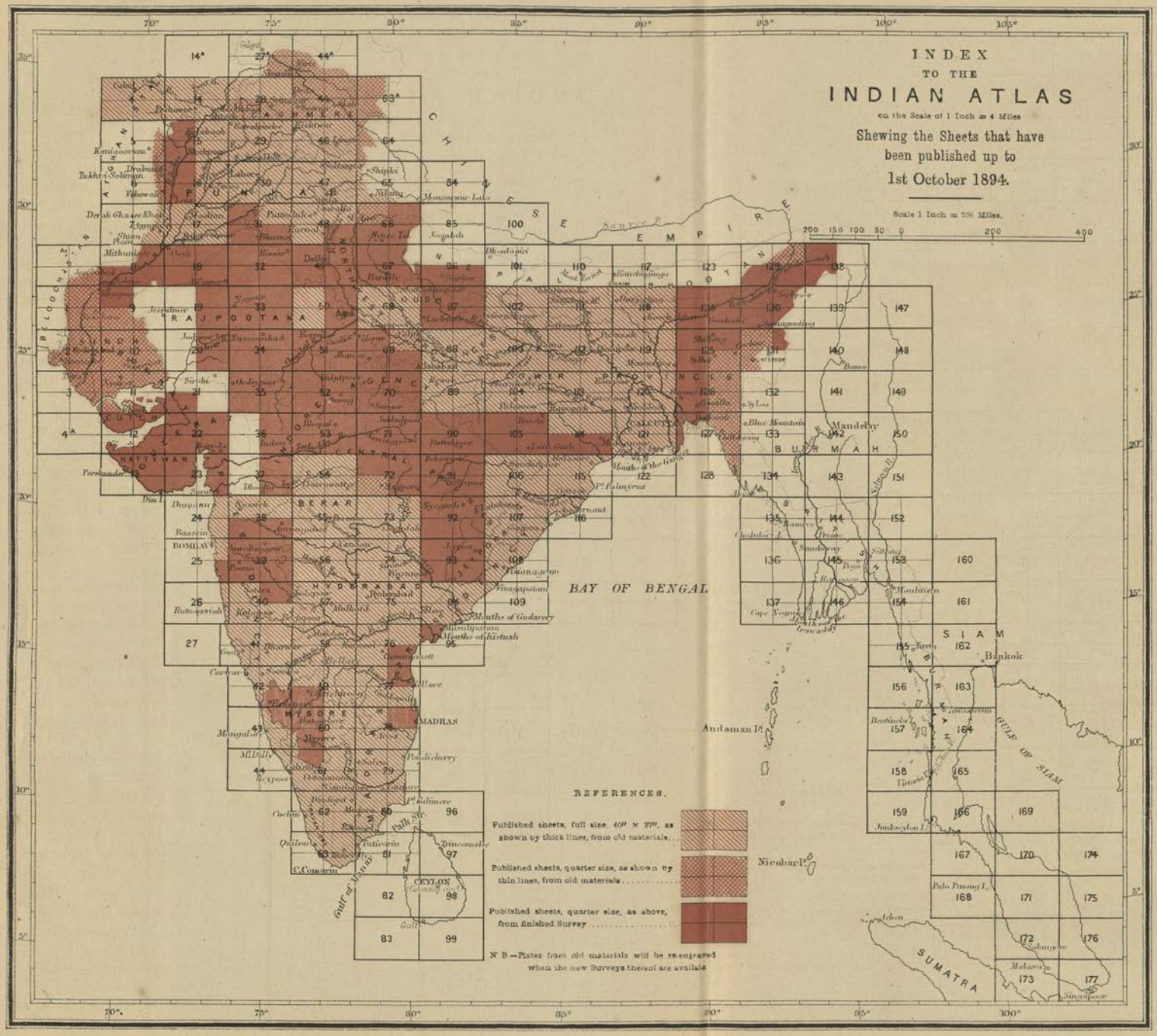
683. Of the provincial maps, the new map of the Bombay Presidency, on the scale of 16 miles=1 inch, has been completed in outline as far as material is available, and the writing is well advanced. The three plates of the Madras Presidency, on the same scale, are in progress, the outline having been completed as far as material is available. The map of Gujarat is well advanced in writing, as well as the two plates of the North-Western Provinces and Oudh; both of these are on the scale of 16 miles=1 inch. A map of Bengal, on the scale of 80 miles=1 inch, has been completed, and one on the 64-mile scale is in progress.

684. The engraving of the map of the city of Calcutta, on the scale of 16 inches=1 mile, in nine plates, was commenced during the year and these have been completed in outline, and the lettering will be finished shortly. The ornamentation and the shading of the masonry buildings on these nine plates are well advanced, and it is hoped that the whole map will be ready for publication before the end of 1895. The process of utilising photographic transfer prints for transferring the details to the copper-plate was described in paragraph 586 of last year's report, and has proved to be very successful. It is probable that the process will be of general utility for engraving all descriptions of maps, and it will be especially advantageous in those which contain much fine detail.

685. The Copper-plate Printing Section pulled 24,387 impressions, which is a smaller number than was recorded in last year's report, but this is due to the average size of the plates being much greater this year. The Steel-facing Section dealt with 189 plates.

686 The office has unfortunately been deprived by death of the services of two engravers during the year—one European, Mr. Wells, and one Native, Munshi Abdul Majid, and their loss has been much felt.*

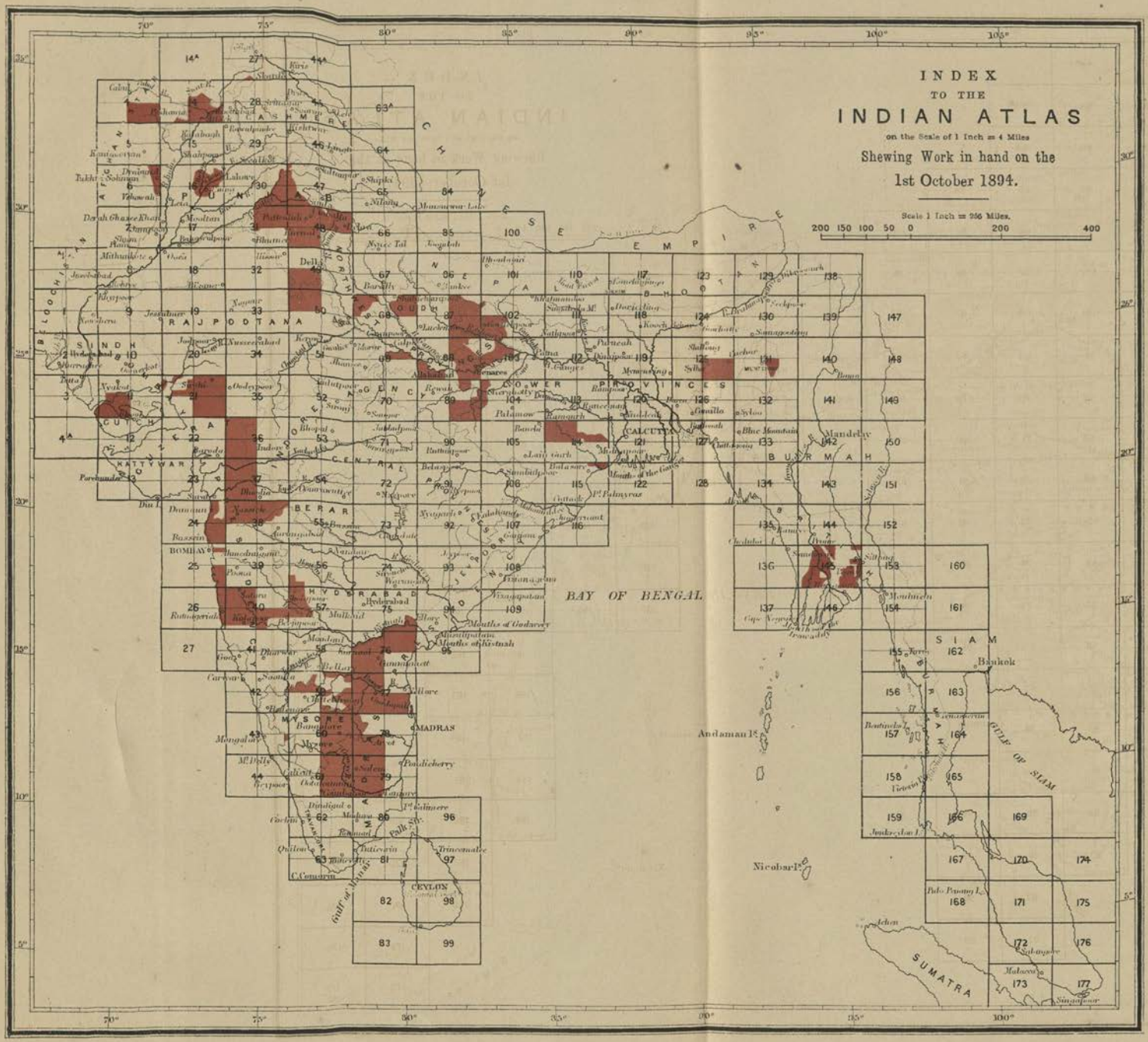
* The Head Engraver, Mr. Fulford, has given great satisfaction in the discharge of his duties, and he reports well of all his establishment.



Reg. No. 603, S. I. D.—Dec. 94.—550.

Litho., S. I. O., Calcutta.

No. 408-S. 94.



Reg. No. 625, S. I. D.—Dec. 94.—550.

Litho. S. I. O., Calcutta.

No. 407-S. 94.

CALCUTTA CITY SURVEY OFFICE.

687. The survey remained under the superintendence of Colonel W. H. Wilkins, S. C., Mr. A. J. Wilson, Extra Assistant Superintendent, being in immediate charge.

Personnel:
Colonel W. H. Wilkins, S.C., Superintendent, 1st grade, in charge.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade.
Babu Sarat Chunder Sen, Sub-Assistant Superintendent, 2nd grade.
7 draftsmen.
1 field surveyor.

688. The survey, which has been executed on the scale of 50 feet to an inch, was commenced in the end of 1886, and the work connected therewith was completed on the 31st August 1894, and the detachment disbanded, the assistants and members of the permanent establishment being transferred to other field parties.

689. The following work has been accomplished during the year:—

(1) The 73 fair sheets, which were reported to be in hand at the commencement of the year under report, were completed, and all sent to press by the 5th March 1894.

(2) Of the block maps, it was stated in last year's report that twelve had been returned after examination by the Municipality, and the sheets contained in them had been published and were ready for sale. The remaining 50 blocks were returned during the course of the year under review, and were all finally sent to press just before the closing of the office on the 31st August 1894. They will be issued to the public as soon as they can be passed through the press.

(3) The claims of the 29 disputed boundaries which remained have been decided in the Court of the Assistant Superintendent of Survey, Babu Tarini Ghose, and in addition to these, 1,528 boundaries were revisited for various causes after the final re-examination of the sheets.

690. With regard to the 16-inch map of Calcutta, the preparation of which was referred to in last year's report, the engraved copper-plates are very well advanced. They will not, however, be completed by the end of 1894, as the work has been much heavier than was anticipated; but it is hoped that they will be ready for publication by November 1895. The system of transferring the photographic prints, taken from reduced negatives of the original fair sheets, direct to the plates by the aid of a thin coating of wax, has proved a perfect success.

691. All the zinc plates of the 236 fair sheets, on which the survey is mapped, are stored in the Photographic Office of this department, and if, at any time, a new edition of a sheet is required, the present survey can be brought up to date and the zinc plate revised. *

* Colonel Wilkins reports that Mr. A. J. Wilson has given great satisfaction in all his duties. He is painstaking and very conscientious, and has done all in his power to complete the work. Babu Sarat Chunder Sen has been very useful in the demarcation of boundaries and the examination of the fair sheets. Of the subordinate native establishment, Munshi Rahim Bux and Ali Jan Beg are well reported on.

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

692. At the opening of the year the office was under the charge of Mr. T. A. Pope until the return of Colonel J. Waterhouse from privilege leave on the 27th October 1893 The latter officer remained in charge until the 2nd July 1894, when he was obliged on account of ill-health to take special leave to Europe, and during his absence Mr. Pope again officiated for him. There have been but few changes in the personnel of the office during the year. Mr. H. Haward, Head Assistant, took furlough for one year from 24th February 1894 and Mr. D. Deas, Head Litho. printer, for one year from 17th April 1894.

Personnel.

Colonel J. Waterhouse, Assistant Surveyor-General, in charge from 27th October 1893, up to 2nd July 1894.

Mr. T. A. Pope, officiating Assistant Surveyor-General, in charge up to 26th October 1893, and from 3rd July 1894.

LITHOGRAPHIC AND PRINTING DIVISION.

Lithographic Drawing Section.

Mr. H. L. Lepage, Head Assistant.
„ E. Dowling, Head Draftsman.
Babu Ambica Churn Mookerji, Draftsman.
Munshi Sobhan Buksh, Examiner.
One apprentice, 28 draftsmen and 6 colourists.

Lithographic and Zinc Printing Section.

Mr. B. Mackenzie, Head Printer.
„ D. Deas, Chromo-litho. printer up to 17th April 1894.
„ S. U. Ravenscroft, Assistant printer.
„ J. B. Mackenzie, ditto
„ P. Michael, ditto from 1st June 1894.
2 machine printers, 1 apprentice, 15 litho. and zinc printers, 9 machinemen, 17 spongemen, 40 pressmen, 1 paper wetter, 2 stone grainers, 2 stone polishers, 4 zinc grainers, 1 ink grinder, 1 engine driver, and 1 fireman.

Type Printing Section.

Mr. E. De Pyvah, Head printer.
11 compositors, 3 type printers, 3 inkmen, 3 mates, 2 machine type-printers, 2 machine inkmen, 1 compositor, 1 impositor, 1 roller moulder, and 1 boy, from 1st June 1894.

NORMAL ESTABLISHMENT.

PHOTOGRAPHIC AND GENERAL DIVISION.

Photographic Negative and Printing Section.

Mr. J. Harrold, Photographer, up to 24th February 1894.
„ C. J. Meade, Asst. Photographer.
„ P. Michael, Do.
„ C. Andrews, Do.
Munshi Ismael Khan, Do.
„ Habibul Hossain, Do.
Mr. F. U. Murphy, Do.
5 Assistant photographers and 8 labourers.

Heliogravure Section.

Mr. A. W. Turner, Photo-engraver.
„ J. T. Meade, Assistan
1 apprentice, 1 assistant photo-engraver.
1 engraver, 1 assistant engraver, 4 copper plate-printers, 6 pressmen, and 11 plate polishers.

Correspondence, Stores and Account Section.

Mr. Moore, Store-keeper.
Babu Kanny Lall Sen, Head clerk and accountant.
„ Kedar Nath Ghose, Clerk.
„ Gopal Chunder Mookerji do.
„ Soorjee Kumar Banerji do.
„ Rajani Kanta Chatterji do.
and 4 clerks and 1 paper-keeper.

CADASTRAL ESTABLISHMENT.

Photographic Section.

Mr. Haward, Head photographic assistant, up to 24th February.
„ J. Harrold. officiating from 25th February 1894.
„ R. George, Photographer.
„ L. Lagnier, do.
„ T. Lloyd, do.
8 Assistant photographers.
10 labourers.

Zinc Printing Section.

Mr. E. A. Lefranc, Zincographer.
„ F. R. Vandyke, do.
„ G. A, Lefranc, Asst do.
Babu Khetra Mohan Dass, clerk.
9 Zinc correctors, 9 zinc printers. 10 spongemen, 17 pressmen and 11 zinc grainers.
1 clerk.

693. The arrangements under the new organisation reported on last year have worked well. It was found necessary, however, to strengthen the Type Printing Section by the addition of a compositor, an impositor, a roller moulder and a boy. With this additional strength no difficulty is now found in meeting the increased demands on this section.

694. The machines have all worked well and have generally been in constant running.

695. The general abstract of work turned out is given in the tabular statement below. Owing to a diminution in the number of subjects received for reproduction, the work in the Photographic and Drawing sections shows a decrease from that of last year; but the out-turn of the lithographic, zincographic

and type-printing presses is again considerably larger and is well over a million pulls.

General Abstract of work done during 1893-94.

Classification.	Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.								Type-printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates, printed.	Stones.	Pulls.	Number of Copies. Coloured.	Uncoloured.	Total.	Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.	
																				R a. p.
Departmental maps, etc.	1,027	1,339	1,523	505	730	92	361,734	46,636	305,366	352,002	10,785	1,564,453	820,605	69	2,220	3	2,136	...	18	98,760 2 6
Cadastral maps	4,673	3,418	3,566	4,716	4,716	...	168,772	...	159,142	159,142	...	...	...	...	...	...	...	...	...	67,771 7 3
Extra Departmental maps and plans	1,162	796	746	354	535	394	508,565	121,361	443,400	564,761	...	...	...	1,296	428	83	48,54	4	...	71,141 10 8
Totals	6,862	5,553	5,835	5,575	5,981	486	1,039,071	167,997	907,908	1,075,905	10,785	1,564,453	820,605	1,355	2,648	86	50,678	4	18	2,37,673 4 0
Totals of 1892-1893	8,365	6,946	6,278	6,492	6,656	808	1,026,682	200,322	806,863	1,007,185	11,210	1,418,607	693,668	1,269	2,892	85	61,082	80	19	2,48,850 5 9
Differences	− 1,503	− 1,393	− 443	− 917	− 675	− 322	+ 12,389	− 32,325	+ 101,045	+ 68,720	− 425	+ 145,846	+ 126,937	+ 96	− 244	+ 1	− 10,404	− 76	− 1	− 11,177 1 9

The out-turn of the lithographic and zincographic presses and machines was 1,039,071 pulls, which shows an increase of 12,389 over last year's return. The number of printed copies shows, however, a much larger increase, being 1,075,905, or 68,720 more than last year. The number of departmental maps, etc., reproduced was somewhat smaller than in the previous year, but the printed out turn, both in pulls and copies, is nearly doubled. In the same way, the number of cadastral maps reproduced is very much smaller, though the number of printed copies is larger, due to the fact that the number of Burma sheets, of which 34 copies each are printed, increased from 1,678 to 3,133 or nearly double, while the number of North-Western Provinces sheets, of which only about 12 copies are printed, decreased from 2,500 to 831. The number of Assam sheets reproduced was only about half as many as in the previous year.

The type-printing section again shows a large increase in the printed out-turn, both in pulls and copies, though the number of items set up was not so great. This is due to the fact that the type for almost all the standard forms is kept standing. The work of the silver printing section shows a small increase of silver prints and a decrease of blue prints. The heliogravure section shows a falling off in heliogravure prints and in photo-blocks, but the number of plates reproduced and of electrotypes remain much the same as in last year.

696. The issue of the new third edition of the 32-mile map of India has again been delayed on account of corrections and additions. These have now been completed with the exception of the new boundaries in the North-Western frontier, and the map must remain in abeyance till the final delimitations are settled.

697. The general and provincial maps published during the year include a map of Indo-China, in 4 sheets, on the scale of 1 inch = 32 miles, printed in two colours; a military map of India on the scale of 1 inch = 32 miles and a map of the Bombay Presidency on the same scale. A new edition of the 24-mile map of Afghanistan has been taken in hand to be chromo-lithographed in three colours: the outline and names in black have been completed and proof submitted for examination. On its return the drawing of the hills to be printed in brown and of the streams in blue will be proceeded with. A new and largely corrected edition of the skeleton map of India on the scale of 1 inch = 64 miles, in two sheets, showing districts, was drawn on stone but not printed off. A map of Sind on the 16-mile scale, was reprinted with corrections; also a map of Upper Burma on the same scale.

698. The only divisional map published during the year was Allahabad, Nos. I and II, in 2 and 4 sheets, respectively, on the scale of 1 inch = 4 miles, revised up to April 1892.

699. The following district maps on the scale of 1 inch = 4 miles, taken from the engraved Atlas sheets, have been printed off during the year:—Hooghly with additions, Bhagalpur, Goalpara, Cachar, Nadia, Palamau, Tippera; also second editions of Naga Hills and Ruby Mines.

700. Three hundred and twenty sheets of standard maps on the 4-inch, 2-inch, 1-inch, ½-inch, and ¼-inch scales have been in hand and 81 were published during the year, including 7 of Bengal, 11 of Bombay, 3 of Burma, 1 of Central India and Rajputana, 32 of the Central Provinces, 1 of Hyderabad, 4 of the North-East Frontier, 7 of the South-East Frontier, 13 of the North-Western Provinces and Oudh and 2 of the Punjab.

701. One hundred and twenty-seven sheets of the Calcutta Survey, on the 50-feet scale, have been published during the year. The remaining sheets of the survey were in hand and have since been printed off, so that the work is now completed. The sheets have also been reduced and photo-transfer prints supplied for the use of the engravers in preparing the new 16-inch map by hand-engraving, as reported last year.

702. Among other plans of cities and cantonments published may be noted a second edition of Quetta Civil Station, on the scale of 16-inches=1 mile, Kolhapur City and environs, 8 inches=1 mile, and the Civil Station of Taunggyi, on the scale of 10 inches=1 mile.

703. Among the miscellaneous maps, 55 sheets of the Madras forest surveys and 38 of the forest reserves in district Jalpaiguri have been printed off; also 5 sheets of gold-mining grants in district Katha.

704. The extra-departmental work shows a considerable decrease, only 1,162 subjects having been reproduced, against 1,673 in the previous year, while the number of pulls from zinc or stone is 508,565, as against 679,245 in the previous year: this is due to smaller demands from other departments. In the silver printing and heliogravure sections also, the extra-departmental work has been less than last year.

The principal item in the extra-departmental work done during the year has been 28 plates for the new Statistical Atlas, of which 25 have been lithographed, mostly in colours, and 3 photozincographed; of these 21 plates have been printed off. The remaining 23 plates of the Bower Manuscript were photo-etched and 17 plates printed, leaving 6 plates to be printed at the close of the year.

705. For the Geological Survey Department a map of Hazara, on the scale of 1 inch=2 miles, was photo-zincographed and colour plates prepared but not printed off; also a Geological map of India on the scale of 1 inch=32 miles, was prepared and printed for hand colouring.

Plans of the Gohna Landslip were also prepared and printed. One hundred and fifteen plates illustrating Mr. Smith's Report on the Mogul Architecture of Fatehpur Sikri, Vol. I, were printed and the work has since been completed and the plates of Vol. II, have been taken in hand. A large series of plates illustrating the Berlin Water-Works and Sewerage system, were reproduced for the Sanitary Board in Bengal. Nine sheets of a plan of George Town, Penang, were photo-zincographed for the Colonial Secretary, Straits Settlements. For the Meteorological Departments, India and Bengal, a very large number of weather charts and diagrams have been printed and a new issue of the rainfall map of India, published in January 1884, is in hand. A large plan of the town of Amritsar has been lithographed for the Municipality, but not yet printed off.

706. The Heliogravure Section has been well employed during the year; 86 plates were prepared by the photo-etching process and 50,678 copies printed.

The principal work of this kind done during the year was 23 plates of the Bower Manuscript, completing the work; the reproduction of 12 more of the very delicate Indian ink drawings of fishes, crustacea and echinodermata to illustrate the Zoology of the Royal Indian Marine Survey Steamer "*Investigator*"; 10 plates of a catalogue of coins for the Indian Museum; 14 plates of the Technical Art Series, including a double plate illustrating *koft* (inlaid damascene) work from the Punjab, with the details of the ornament shown in outline to full scale; and a series of plates of vertebræ to accompany a paper by Surgeon-Captain R. H. Charles, M.D., in the Scientific Memoirs by the Medical Officers of the Army in India. The annexed view of Calcutta taken from the tower of the Telegraph Office by Mr. T. A. Pope has been reproduced by the process.

707. Further experiments in balloon photography were again made with the apparatus lent from Chatham for the purpose, but the results were not at all successful owing to the wind preventing overhead photographs being taken, and also to the angle of view embraced by the lens being too small for the heights at which the captive balloon could be used. It seems doubtful whether small

Photo-etching. Survey of India Offices, Calcutta, August 1894.

IN THE CITY OF PALACES.

From a negative by T. A. Pope.

captive or free balloons could ever be depended upon for photographic reconnaissance work, though no doubt they might be useful under favourable circumstances.

708. Further details of the work performed in the Photographic and Lithographic Office are given in Colonel Waterhouse's report in the appendix.

MAP RECORD AND ISSUE OFFICE.

Personnel.

Mr. T. A. Pope, Deputy Superintendent, 2nd grade, in charge up to 24th November 1893, and from 1st May 1894.
Captain W. J. Bythell R.E., Deputy Superintendent, 2nd grade, in charge from 25th November 1893, up to 30th April 1894.
Mr. F. A. D'Rozario, Head Clerk.
„ H. R. Vallis, Map Curator.
„ J. A. Vallis, clerk, and 15 other clerks.

709. During the year under report the charge of this office has been held by Mr. T. A. Pope, and Captain W. J. Bythell, R.E., at different periods.

710. The number and value of maps issued during the year are as follows:—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	1,52,588	70,157
Ditto to India Office, London	1,982	3,097
Ditto to Agents	2,386	3,027
Ditto to private individuals	7,018	9,393
TOTALS	1,63,974	85,674
Cadastral maps to Government officials	1,25,941	79,121
GRAND TOTALS	2,89,915	1,64,795

711. There has been a decrease in the number of maps issued during the year, owing to the smaller demands both by Government officials and private individuals. The value of the maps issued is, however, greater. The number and value of maps issued during the preceding year were 3,23,263 and ₹1,50,974 respectively, showing in the year under report a decrease of 33,348 in number, and an increase of ₹13,821 in value.

712. The amount realised from cash sales of maps was ₹23,096, *viz.*, ₹9,393 from private individuals, ₹1,285 from agents, and ₹12,418 from Government officials. This is a decrease of ₹10,207 on the cash receipts of the previous year.

713. In the Revenue section, 776 applications were received for extracts from original records of the Revenue Surveys, and 1,845 for certified copies of village plans, tracings and traverses, which were all supplied at a charge of ₹14,475.

* Colonel Waterhouse again reports very favourably of all his principal assistants, *viz.*, Messrs. H. L. Lepage, B. Mackenzie, E. A. Lefranc, Sergeant Vandyke, E. DePyvah in the Lithographic, Zincographic and Type Printing Sections; Messrs. H. Haward, A. W. Turner, J. Harrold, R. George, and L. Lagnier in the Photographic Sections, and Mr. Moore, storekeeper. The following junior assistants and apprentices are reported to have worked well:—Messrs. J. B. Mackenzie, E. Dowling, G.A. Lefranc, S. U. Ravenscroft, C. J. Meade, J. T. Meade, P. Michael, C. Andrews, F. U. Murphy, C. L. Green, N. J. Gonsalves, and J. Vieux who was appointed an apprentice in the Negative Section and has made good progress in learning his work. In the Lithographic Drawing Section, Babu Ambica Churn Mookerji, and Munshis Subhan Buksh, Abdul Hamid, Abdul Hakim, and Babu Dina Nath Dass may be specially noticed among the native draftsmen, but they have all worked well. Among the native assistants in the Photographic Sections, Mohamed Ismail, Habibul Hossain, Abdul Rahman, Ambika Churn Bhuttacherji and Preo Nath Chatterji, Assistant Photographers, Azizur Rahman, Native Engraver, and Aghore Nath Sircar, Copper Plate printer, have worked very satisfactorily. In the Correspondence and Accounts Sections Babu Kanny Lall Sen, the Head Clerk and Accountant, has again worked very zealously; Babu Kader Nath Ghose, Gopal Chunder Mookerji, Surja Kumar Banerji, Rajani Kanta Chatterji, and Nojendra Nath Mookerji have also done their work well.

714. The details of work done are given in the following statement, and they will be found to correspond closely with those of the preceding year:—

Details.	Number.
Applications received for maps	5,213
Letters issued in reply	3,597
Cash and credit map sale bills	1,434
Invoices and receipts issued for published maps	2,651
Ditto ditto for cadastral maps	385
Ditto ditto for extracts from original records	284
Packets, parcels, and local despatches	4,918
Ditto received in the office	851
Packages despatched by rail and steamer	612
Ditto received ditto	64
Maps coloured for sale and issue	28,600
Ditto for other departments	718

A list of the maps and charts published during the year will be found a p. 128.*

MATHEMATICAL INSTRUMENT OFFICE.

715. For almost the whole period under report the charge of this office has been held by Colonel M. W. Rogers, R. E., Assistant Surveyor-General, who also held the appointment of Patents Secretary up to 31st December 1893, from which date the Officer in charge of the Mathematical Instrument office was relieved of the charge of the Patents Office.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, up to 17th October 1893.
Colonel M. W. Rogers, R. E., Assistant Surveyor-General, from 18th October 1893.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker.
Mr. T. R. Theakston, Assistant Mathematical Instrument Maker, from 1st November 1893.
200 Artificers.

Store Branch.

Mr. M. C. Belletty, Instrument Store-keeper.
Babu Womesh Chunder Chowdhury, Material Store-keeper.
1 packing sircar and 2 packers.

Officer Establishment.

Mr. W. Campagnac, Head Clerk.
Mr. W. R. Tulloch, 2nd Clerk.
6 clerks and 3 temporary clerks.

716. The figures in this report refer to the financial year, *i.e.*, from 1st April 1893 to 1st March 1894. During this period 75,617 serviceable instruments valued at ₹4,24,529, were received into store, and 63,728 instruments valued at ₹2,47,111, were issued. In comparison with the preceding year, this shows a considerable decrease in the number, and a large increase in the value of the instruments received. This is due principally to the large number of low priced instruments which were received during the previous year. The issues, as compared with the previous year, show a decrease both in number and value, due in a great measure to the smaller requirements for railway surveys and all kinds of work as shown below:—

	1892-93.	1893-94.	Increase.	Decrease.
No. of instruments received	1,08,654	75,617	...	33,037
Value of ditto ₹	2,77,280	4,24,529	1,47,249	...
No. of instruments issued	1,00,827	63,728	...	37,099
Value of ditto ₹	2,97,150	2,47,111	...	50,039

* Mr Pope reports favourably of the services rendered by Mr. D'Rozario. Mr. H. R. Vallis is deserving of special mention for the manner in which he has conducted the arduous duties of Map Curator and Salesman; Messrs. J. A. Vallis, Hazra, and Belletty are also well reported on.

From this table it is seen that the number of serviceable instruments in store, has increased by 11,889 and their value by R1,77,418.

717. The following statement shows the principal sources from which the serviceable instruments were received :—

Sources of Receipt.	Number.	Value.
		R
From England on indent	27,842	2,61,103
By purchase in the local market	13,651	35,067
Manufactured in workshop	21,345	37,601
Returned to store by public officers . . .	8,783	11,131
From repairable stock after repair . . .	3,974	79,613
From other sources	22	14
TOTAL .	75,617	4,24,529

718. The number and value of the instruments received from England has increased considerably; this was necessitated by the state of the stock of instruments, which had become unduly low. The purchases in the local market were less than in the previous year owing to a larger number of instruments being received from England and to the decrease in the number of instruments issued. The value of the instruments manufactured in the workshop is a little less than the amounts in each of the two former years. The class and value of the instruments manufactured will be found in Table C in the appendix.

719. The number of instruments taken from the repairable stock and rendered serviceable for issue is considerably greater both in quantity and value than in the preceding year. During this year the office has received 5,977 repairable instruments, valued at R76,899, against 3,045 instruments valued at R49,021 in the previous year. The total issues from repairable stock were 3,976 instruments, valued at R48,135. These were repaired in the workshops at a cost of R31,478, and transferred at an enhanced value to the serviceable stock. The repairable stock has thus been increased by 2,001 instruments valued at R28,764. This result shows that, owing to the much larger number of instruments in use in India on various works, the returns to store of repairable instruments is increasing, and the establishment is not strong enough to clear off all current repairs (its first duty), and also to render serviceable all the instruments returned to store; the repairable stock is therefore beginning again to accumulate.

720. The conversion of old pattern levels and theodolites alluded to in paragraph 616 of last year's report has been continued, and in the year under report 39 levels and 9 theodolites of obsolete patterns were converted into serviceable instruments and issued. The levels dealt with have been the old and useless Y levels on 4 foot screws, which have been converted into the new pattern of Bolton's reversible level; their total issue price was R8,465, and their value before conversion was almost nothing. The grant for the special extra establishment for converting levels and theodolites expired on 30th June 1894: it has now been made permanent, and the conversion of the stock of old pattern levels and theodolites (which is practically inexhaustible) will be steadily proceeded with.

721. During the year the number of indents complied with was exactly the same as in 1892-93. They were of the ordinary kind, and call for no comment. The office still continues to do a considerable amount of work for the Ordnance Department, chiefly repairs and adjustments of Scotts' sights and Watkins' range-finders.

722. The payments in cash for charges under R50, alluded to in paragraph 619 of last year's report, has again greatly increased; these involve a large amount

of miscellaneous correspondence with regard to non-payment, etc., in addition to the increased work of the ordinary routine of submitting cash bills, and receiving payments. The amount of cash passing through the office in payment for small supplies, etc., was ₹38,037 in the year under report, being an increase of ₹10,000 over last year, and is ₹23,000 greater than in the year 1890-91, at the end of which the new rules were introduced. These figures show plainly the great increase of responsibility and work thrown on the office in consequence of these rules.

723. Table A (in the appendix) shows the amount of debits against various offices and departments for instruments supplied and for work done. It also exhibits the credits for all instruments and materials returned into store. The values of the issues and repairs executed on book-debit was ₹2,19,450, being ₹67,603 less than last year. This amount includes the value of instruments purchased with the extra departmental grant of ₹45,000, of which only ₹29,500 was expended. The credits for instruments returned into store amounted to ₹89,442, which is considerably more than in the previous year, but agrees well with the general value under this head. The grand total of supplies, including cash sales, is ₹2,57,487, being a decrease of ₹57,752. This large diminution is probably due to the suspension of works in India from financial causes.

724. The number of principal instruments repaired in the workshop is 2,823, or a little over 100 more than last year. The total number of instruments of all kinds repaired amounts to 3,941 or 300 more than in 1892-93.

725. It will thus be seen that, during the year under review, the demand for instruments from the stores has been considerably less than in the previous two years, but the actual work carried out in the workshops has been rather more than in the previous year, the total value of all the work done in 1893-94 being ₹1,33,706, against ₹1,20,323 in 1892-93. The number and value of instruments issued depends on conditions entirely beyond the control of the office, but the value of the work done is a direct test as to whether the workshop establishment has worked well.

726. The stock-taking which has been in hand since March 1892, was completed this year, having been proceeded with at intervals when one of the instrument-makers could be spared from his current duties to assist the officer deputed for the work. The results were submitted to the Surveyor-General and approved by him as satisfactory. Stock had not been taken since the transference of the office from the old building in 1888, and in many cases it was found very difficult to check the repairable stock.

727. The profit and loss account of the workshop will be found in the appendix, the result of the operations showing an apparent profit of ₹7,772. This year, in accordance with the auditor's instructions, half the rates and taxes of the office have been charged against the workshop, as well as a sum of ₹3,948 as liability for pensions; the resulting profit is, however, too high, and rates will be revised.*

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

728. During the year under report the office underwent considerable alteration both in character and *personnel*. The general superintendence of the office up to 30th April 1894 was in the hands of Colonel G. Strahan, R. E., Deputy Surveyor-General in charge Trigonometrical Surveys; on his retirement the post held by him was abolished, and Major St. G. Gore, R.E., who succeeded to the charge of the office, was appointed thereto under the title of Superintendent of Trigonometrical Surveys.

* Colonel Rogers reports that Mr. Bolton has continued to perform the duties of Mathematical Instrument Maker with his usual zeal and ability; he is a very intelligent and praiseworthy officer, and a valuable servant to the Government. Mr. Theakston, who was appointed permanent Assistant Mathematical Instrument Maker from 1st November 1893, had already officiated in the appointment on two former occasions for three years in all: he is a hardworking and zealous officer, and is now capable of carrying on the duties of the Mathematical Instrument Maker when necessary. This he did during Mr. Bolton's absence on privilege leave for three months.

The Correspondence and Store Branch under Messrs. Campagnac, Belletty, and Tulloch, have worked satisfactorily during the year, and these officers report favourably on their subordinates, making especial mention of Babus Durga Churn Ghose, Gossain Dass Ray, Shib Chunder Ghose, and Womesh Chunder Chowdhury, the Material Store-keeper.

729. The extra staff of computers which had been sanctioned as a temporary measure in May 1890 for pushing on the final reduction and publication of the records of previous years appertaining to the triangulation of India proper, was dispensed with at the end of April 1894. Special reports have been submitted to the Government annually showing the progress made in this work, and it will suffice to state that the work for which the establishment was entertained has been practically completed, and with the exception of one volume on the tidal operations and three volumes of the synoptical results, the whole of the account of the operations in India proper of the Great Trigonometrical Survey of India has been published.

Personnel.

Superintendence.

Colonel G. Strahan, R.E., Deputy Surveyor-General, in charge Trigonometrical Branch up to 30th April 1894.
Major St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, from 1st May 1894.
Mr. J. Eccles, M.A., Deputy Superintendent, 2nd grade, in charge Computing Party.

(1) Computing Section.

Mr. H. W. Peychers, Extra Assistant Superintendent, 2nd grade.
Mr. A. Christie, Extra Assistant Superintendent, 3rd grade.
Babu Kali Mohan Ghose, Senior computer, and 33 other permanent and temporary computers, record and account-keeper, librarian and writer. — Till 30th April 1894.
Babu Amba Pershad, computer, and 8 other computers, 2 copyists and 2 writers. — From 1st May 1894.

(2) Printing Section.

Mr. B. V. Hughes, Printer.
20 compositors and temporary hands . . . . Till 30th April 1894.
9 compositors and 2 distributors . . . . From 1st May 1894.

(3) Photo-zincographic Section.

Mr. J. S. Manuel, Assistant Zincographer.
2 assistant photographers, 2 draftsmen, 1 map-keeper — Till 30th April 1894.
2 photographers, 6 plate correctors, 5 retouchers, 4 zinc printers, 12 assistant zinc printers, 1 accountant, 1 store-keeper, 1 despatcher. — From 1st May 1894.

(4) Correspondence Section.

Mr. J. Burbridge, Head Clerk, and 3 writers.

(5) Stores, Workshops, and Observatories Section.

1 writer, 1 head artificer, and 3 artificers.

(6) Drawing Section.

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 4th grade.
4 draftsmen, 1 sub-surveyor, 12 assistant and apprentice draftsmen. — Till 30th April 1894.
4 draftsmen, 1 sub-surveyor, 2 assistant and 8 apprentice draftsmen. — From 1st May 1894.

(7) Solar Photographic Section.

Mr. C. F. Guthrie, Assistant Solar Photographer.

730. The office was re-organised in the following way:—All temporary grants with one small exception were withdrawn, and within the limits of the old permanent grant, it was so arranged that the Photo-zincographic section was largely increased, principally at the expense of the Computing section, to meet the ever increasing demands for the supply of maps. A grant of ₹10,000 was sanctioned to carry out the necessary alterations in the office buildings.

731. The office is now divided into the following sections:—

(1) Computing.
(2) Printing.
(3) Photo-zincographic.
(4) Correspondence.
(5) Stores, Workshops, and Observatories.
(6) Drawing.
(7) Solar Photography.

(1) Computing Section.

732. The work in this section consists in examining and finally reducing the field records of the Trigonometrical Branch; and preparing suitable abstracts for publication in the regular series of volumes issued by the Department: the latter entails the examination of and passing for press all printed matter set up in the Printing section. From time to time it affords help to field parties in their calculations, and meets all demands for data required by officers of this and other departments. The astronomical and other observations taken by officers of the Quarter Master General's Department are generally also reduced in this section, and various other miscellaneous work is performed which will be found in the appendix.

733. During the year seven fresh instalments of field records were received and stored, and twenty-two requisitions for data were met. The computations for the synoptical volume of the North-East Longitudinal Series were resumed, and about one-third of the angle books examined. Some of the Revenue Survey levels in Lower Burma were reduced to accord with the latest determinations of sea-level. The traverses of Palwal Town and Municipality survey were reduced.

The preparation of press copy and the examination of press proof was carried on as usual, the amount of progress corresponding to that in the printing section. The examination of the chart of the Spirit-Levelled Heights, No. 1 Burma, was finished, and that of the Synoptical volume of the Kathiawar Meridional Series nearly completed. A considerable amount of professional work was expended in connection with the protection of survey stations: thirty districts, out of 346, failed to submit reports. The usual meteorological observations were taken. The observations taken by two officers of the Quarter Master General's Department were reduced.

(2) *Printing Section.*

734. The work in this section will be found detailed in the appendix: the following is the progress made:—

(*a*) Spirit-Levelled Heights, No. 1 Burma, finished.
(*b*) Imperial Forest School calendar finished.
(*c*) Synoptical volume XXXIV of the Kathiawar Meridional Series, practically finished.
(*d*) Synoptical volume XXIX of the Great Arc Meridional Series, two-thirds completed.
(*e*) Tidal volume some 200 pages printed.

Besides this a great amount of work was done in printing the letter-press for charts, map-heading and foot-notes, and in turning out office and professional forms required by the department.

(3) *Photo-zincographic Section.*

735. This section has been working at high pressure during the year and has not yet been increased to its full strength, as the plant has not arrived from England. Every endeavour has been made to meet the requirements of the various departments, and it is expected that in the coming year the issue of maps will be greatly accelerated. The arrears that had accumulated have almost entirely been cleared off. Full tabular statements will be found in the appendix.

(4) *Correspondence Section.*

736. This has been conducted as usual.

(5) *Stores, Workshops, and Observatories Section.*

737. This is a new section: the work done was formerly included in the correspondence section.

(6) *Drawing Section.*

738. The amount of work required from this section by the Photo-zincographic section is so great that it can with difficulty cope with it, and hence little compilation has been done: it is hoped that more will be shown in next year's report. The out-turn, which will be found detailed in the appendix, includes the following:—

One map compiled for the Quarter Master General; twenty traverses plotted for the Deputy Commissioner, Gurgaon, and seven for the Junagadh State; corrections to three standard maps completed and the second edition of the Dehra Municipality map partly finished; two triangulation charts completed and four others taken in hand; five diagrams for the tidal volume completed, and fourteen taken in hand; one thousand eight hundred and forty-five maps coloured.

(7) *Solar Photographic Section.*

739. The work of this section was continued as usual.

740. The training of officers of other departments, which is part of the work of this office, was carried out, one officer availing himself of the instruction.

741. During the year two native explorers employed by the department returned from their journeys; their work was reduced and their diaries prepared for press.

742. The offices were inspected in October 1894 by the Surveyor-General, who was quite satisfied with the progress that had been made during the year and with the general state of the records as well as with the general efficiency of the establishment.*

III.—DRAWING OFFICE, SIMLA.

743. This office continued under the personal superintendence of Colonel Holdich during the greater portion of the year, but the charge of it devolved upon Mr. G. W. E. Atkinson from the 16th November 1893 to the 12th April 1894, during which period Colonel Holdich was engaged in the field.

Personal.

Colonel T. H. Holdich, C.B., C.I.E., R.E., Superintendent, 1st grade, in charge.
Mr. G. W. E. Atkinson, Officiating Assistant Superintendent, 1st grade.
„ T. H. Rendell, Extra Assistant Superintendent, 4th grade, from 24th January 1894.
„ W. J. Cornelius, Extra Assistant Superintendent, 5th grade.
„ A. Kitchen, Extra Assistant Superintendent, 6th grade, up to 14th Novemher 1893.
„ F. E. Warde, Sub-Assistant Superintendent, 2nd grade.
„ P. Williams, Probationary Sub-Assistant Superintendent, 3rd grade, up to 28th February 1894.
„ F. Rozario, Surveyor.
„ H. Sindon, Draftsman.
Munshi Jafir Khan, Draftsman,
Mr. W. Manly, Draftsman, and four other draftsmen.

744. During the year new editions of both the Turkestan and Baluchistan maps (each in four sheets) were completed and forwarded to the Dehra office for reproduction. The publication of the former map, however, is delayed for want of orders from the Government regarding the boundaries therein. The map of Afghanistan, also in four sheets, on the 16-mile scale, was taken in hand and very nearly completed at the close of the year. This map would have been completed much earlier but for the necessity of incorporating with it a large area of new survey on the 8-mile scale by Surveyor Sheik Mohiuddin, and a large accumulation of reconnaissance surveys executed by Intelligence officers, all of which had to be adjusted on the 8-mile scale standard maps, and then finally reduced for incorporation with the sheets of the map of Afghanistan. These additions will more than compensate for the delay caused in bringing out the map.

745. The revision of the sheets of the North-West Trans-Frontier Series and the South-West Asia Series has very seriously taxed the resources of this small office during the year. On taking in hand the second editions of these sheets it was found that no less than 19 of them have been affected by the surveys and reconnaissances of recent years. The strain caused by this work was especially felt owing to the absence of more than one draftsman in consequence of ill health.

746. Of the miscellaneous work done, the map illustrating Mr. Butcher's traverse from Bushire to Bandar Abbas, undertaken at the request of the Intelligence Branch of the Quarter Master General's Department, is perhaps the most important. It reflects much credit on Mr. Butcher, of the Telegraph Department, for the intelligence and skill he brought to bear on the execution of his field work.

747. Perhaps the largest undertaking that will be required from this office at present is the map of Persia, in six sheets, on the scale of 16 miles=1 inch. This has already been commenced and the printing of one of the sheets is in hand, but it will be some time before all the sheets are ready for the press. It is hoped that the large additions in the recent surveys will combine to render the map the best and most complete as yet published.

* Mr. Eccles reports very highly of the work done by his assistants, Messrs. Peychers, Christie, McA'Fe, Hughes, Manuel and Guthrie, and speaks well of the computers.
The Superintendent reports very favourably of the assistance rendered him by Mr. Christie and Mr. McA'Fee.
The correspondence office has carried on its work satisfactorily during the year.

748. In the early part of the year, the office sustained a very severe loss in the untimely death of Mr. A. Kitchen, whose accomplishments as a draftsman had contributed in no small degree to the success of the general mapping.*

IV.—FOREST SURVEY BRANCH OFFICE, DEHRA DUN.

749. The Head-quarters Office of the Forest Survey Branch is located at Dehra Dun, and throughout the year it has been under the direct supervision of Mr. W. H. Reynolds. The following classes of work are dealt with :—

(1) Correspondence, accounts and Forest Department map records.
(2) Final computations of the several field detachments.
(3) Drawing and compiling of special maps for the Forest Department.
(4) Training of surveyors for forest work.
(5) Other miscellaneous work for the Forest Department.

750. The map records of the forests in the several provinces under the Government of India as well as Madras, have been posted up to date. These maps comprise a series of the best available maps on various scales for each forest reserve; district maps illustrating the reserved and protected forests according to forest divisions; and provincial maps showing forests by forest circles or Conservator's charges; also a general map of India on which is shown the entire forest areas that have been gazetted to date under the Indian Forest Laws. The last acts as an index to the several provincial portfolios.

751. The tabulated statements as well as the alphabetical lists connected with the foregoing map records are fairly advanced towards completion. These statements, which are in bound volumes, contain references to the best available forest maps of each reserve as well as to the numbers and dates of all Government notifications, whereby each forest has been constituted a reserved or protected forest, and numbers and dates of notifications authorizing changes from time to time in forest boundaries.

752. During the year a catalogue has been compiled and printed of the maps in deposit in the Forest Survey Office; it contains 250 pages and the maps are recorded under the following headings :—

i. Forest maps of areas surveyed and published by the Forest Survey Branch.
ii. Forest and other maps published by the Forest Survey Branch for special purposes.
iii. Forest maps surveyed and published by the Survey of India and Madras Revenue Surveys.
iv. Other maps published by the Survey of India Department on which forest areas have been located and sketched in in the Forest Survey Office.
v. Other maps in deposit on which no forest areas are entered at present.

The catalogue contains a complete list of printed maps that are at present available for forest purposes.

753. For forest working plans, in several provinces, numerous areas have been deduced, comprising chiefly areas of forest blocks and compartments, areas for exchanges of land, areas of different classes of forests, etc. Seventy-five 4-inch maps as well as various other maps on smaller scales have been dealt with under this head.

754. For the several Provincial Forest Departments, 97 special maps and maps of tracts surveyed by the Forest Survey Branch have been published during the year; 108 map sheets are in the press, and 88 maps are in progress or in different stages of completion.

* Colonel Holdich reports that Mr. Atkinson has done good service during the year, not only while in charge of the office, but also as a compiler and draftsman. He works well with the Intelligence Branch, and adapts himself to the requirements of that office as well as of his own.

Mr. Cornelius is reported to have maintained his good reputation and to have worked with both skill and energy. On him, since Mr. Kitchen's death, has fallen the bulk of the delicate hachuring required for the small scale maps.

Of the draftsmen, Messrs. Sindon and Rozario, and Munshi Jafir Khan, are said to have worked steadily and well.

755. During the recess months or as opportunities offered, 30 apprentices and colourists were trained for forest survey field work; five men qualified in traversing, 24 in plane-tabling and one in triangulation.

756. A vast amount of miscellaneous work was done during the year, included in which is the colouring of 2,730 printed maps and the additions of forest growth records to 29 published sheets; 1,497 maps were cut up and mounted in book form and 177 tracings were prepared for various forest and district officers.

757. This office was inspected by the Surveyor-General in October 1894, who was quite satisfied with the general efficiency of the establishment and with the excellent manner in which the forest map records are kept. The field maps and computations of the different survey detachments were scrutinized and the external evidence thereon showed that they had been executed with care. The test surveys have been carried out systematically and the apparent results are satisfactory. But the European supervision is considered to be insufficient. In some of the Provinces, *e.g.*, in Burma, the professional work was entirely carried out and supervised by native agency, and native surveyors on small pay, *viz.*, ₹60 a month, were made entirely responsible for testing and passing the work. Although Mr. Reynolds may have a few trustworthy men of this class who can be relied on, it cannot be considered an adequate means of guaranteeing good and accurate work as a general rule. With this exception the arrangements and system of the Forest Survey Branch are quite satisfactory, and Mr. Reynolds is entitled to credit for the successful management of his branch.

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1893-94.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Sheet No. 47	1=4	1	With additions to 1894.
Sheets Nos. 79 and 104	1=4	2	With additions to 1892.
Sheet No. 103	1=4	1	With additions to 1891.
Sheet No. 107	1=4	1	With additions to 1888.
Sheets Nos. 113 and 121	1=4	2	With additions and corrections to 1893.
Sheets Nos. 9 S.E.; 12 N.E.; 23 N.E.; 25 S.E.; 42 S.E.; and 49 N.W.	1=4	6	...
Sheets Nos. 1 N.E.; 15 N.W.; 35 N.E.; 67 S.E.; 86 S.W.; 105 N.E., and 126 N.W.	1=4	6	With additions to 1892.
Sheet No. 6 N.E.	1=4	1	With corrections to 1892.
Sheet No. 28 S.W.	1=4	1	With additions to 1889.
Sheets Nos. 22 N.W.; 32 N.E.; 90 N.W.; and 129 S.E.	1=4	4	With additions to 1891.
Sheet No. 31 S.W.	1=4	1	Corrected to April 1886.
Sheets Nos. 69 S.E. and 92 N.E.	1=4	2	With additions to 1887.
Sheet No. 130 N.W.	1=4	1	With additions to 1890.
Sheets Nos. 42 N.E. and 61 N.W.	1=4	2	Preliminary edition.
Sheets Nos. 8 N.E. and 131 S.W.	1=4	2	With additions to 1893.
GENERAL MAPS.			
Bombay Presidency (without hills)	1=32	1	
Bombay Presidency (exclusive of Sind)	1=32	1	
India	1=128	1	With addition to railways to 1893.
Indo-China	1=32	2	
Route map of the Western Himalayas, etc.	1=32	1	With additions to railways to 1893.
PROVINCIAL MAPS.			
Assam, sheets Nos. 4 and 9	1=8	2	With additions and corrections to March 1893.
Mysore (skeleton)	1=16	1	With addition of the Province of Coorg and railways to February 1894.
Sind	1=16	1	With additions and corrections to December 1892.
Berar	1=24	1	...
Upper Burma	1=64	1	With additions and corrections to January 1894.
Bengal	1=80	1	
DIVISIONAL MAPS.			
Allahabad, Nos. 1 and 2 (N.-W. P.)	1=4	6	Revised to 1st April 1892.
Pegu, Sheets Nos. 1 and 3 (Burma)	1=4	2	With additions to railways to 1881.
DISTRICT MAPS.			
Amritsar (Punjab)	1—2	2	With additions and corrections to July 1888.
Bhagalpur (Bengal)	1=4	1	With additions and corrections to June 1892.

TITLE.	Scale.	Number of Sheets.	REMARKS.
DISTRICT MAPS—*continued.*	In. M.		
Goalpara (Assam)	1=4	1	With additions and corrections to October 1893.
Hooghly (Bengal)	1=4	1	With additions to November 1892.
Katha (Burma)	1=4	1	
Nadia (Bengal)	1=4	1	With additions and corrections to May 1892.
Naga Hills (Assam)	1=4	1	2nd edition.
Palamau (Bengal)	1=4	1	
Ruby Mines (Burma)	1=4	1	
Tippera (Bengal)	1=4	1	
Bhamo (Burma)	1=8	1	
STANDARD MAPS.			
Bengal.			
Sheets Nos. 166 and 195 (in one), 196, 221, 222, 247, 248 and 271	1=1	7	
Bombay.			
Sheets Nos. 245 N.E. and 245 S.E.	2=1	2	
Sheets Nos. 85, 158, 183, 190, 223, 240, 272 and 273	1=1	8	
Sheets Nos. 42, 57 (Rajputana), 68, 85 (Bombay)	1=2	1	
Burma (Lower).			
Toungoo District, Sheets Nos. 271 $\frac{S.W.}{3}$; 274 $\frac{N.E.}{1}$; 274 $\frac{N.E.}{3}$; 274 $\frac{N.E.}{4}$; 274 $\frac{N.W.}{2}$; 274 $\frac{N.W.}{4}$; 274 $\frac{S.E.}{1}$; 274 $\frac{S.E.}{2}$; 274 $\frac{S.E.}{3}$; 274 $\frac{S.E.}{4}$, and 274 $\frac{S.W.}{2}$	4=1	11	
Sheets Nos. 232 and 279 (in one)	1=1	1	2nd edition.
Sheets Nos. 235, 236, 237, 564, 572 and 572A.	1=1	6	
Burma (Upper).			
Sheet No. 263	1=1	1	
Central India and Rajputana.			
Sheet No. 57	1=1	1	
Sheet No. 382	1=1	1	Railways corrected to January 1894.
Central Provinces.			
Nimar District, Sheets Nos. 7 $\frac{S.E.}{3}$; 7 $\frac{S.W.}{4}$; 8 $\frac{N.W.}{2}$; 8 $\frac{N.W.}{3}$; 8 $\frac{N.W.}{4}$; 8 $\frac{N.E.}{1}$; 8 $\frac{N.E.}{2}$; 8 $\frac{N.E.}{3}$; 8 $\frac{N.E.}{4}$; 8 $\frac{S.W.}{1}$; 8 $\frac{S.E.}{2}$; 8 $\frac{S.E.}{4}$; 9 $\frac{N.E.}{2}$; 9 $\frac{N.E.}{4}$; $\frac{S.W.}{2}$; 9 $\frac{S.E.}{1}$; 9 $\frac{S.E.}{2}$; 14 $\frac{N.W.}{1}$; 14 $\frac{S.W.}{1}$; 14 $\frac{S.W.}{2}$; 14 $\frac{S.W.}{3}$; 14 $\frac{S.W.}{4}$; 15 $\frac{N.W.}{3}$; parts of 2 $\frac{S.E.}{4}$ and 7 $\frac{S.W.}{3}$ (in one); 3 $\frac{N.E.}{2}$ and 8 $\frac{N.W.}{1}$ (in one); parts of 7 $\frac{N.W.}{4}$, $\frac{S.W.}{1}$ and $\frac{S.W.}{2}$ (in one); parts of 7 $\frac{N.W.}{3}$ and $\frac{N.W.}{4}$ (in one); 8 $\frac{S.W.}{2}$ and $\frac{S.E.}{1}$ (in one); 9 $\frac{N.E.}{3}$ and parts of $\frac{N.W.}{4}$ (in one); 14 $\frac{N.W.}{3}$ and $\frac{N.W.}{4}$ (in one); 15 $\frac{N.W.}{1}$ and part of $\frac{N.W.}{3}$ (in one)	4=1	31	
Hoshangabad and Betul Districts, Sheet No. 24 $\frac{S.W.}{3}$	4=1	1	
Betul District, Sheets Nos. 25 $\frac{S.E.}{1}$; 26 $\frac{N.W.}{1}$; and 26 $\frac{N.W.}{2}$.	4=1	3	

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—*continued.*	In. M.		
Central Provinces—continued.			
Hoshangabad District, Sheets Nos. 23 S.E./4; 24 N.E./2; 24 N.E./4; 34 N.E./3; 34 S.W./3; 34 S.W./4; 34 S.E./3; 35 N.W./1; 35 N.W./2; 35 S.W./2; 23 S.E./1 and S.E./3 (in one); 34 S.W./1 and N.W./3 (in one); 34 N.W./4 and part of N.E./3 (in one) . . .	4=1	13	
Jubbulpore District, Sheets Nos. 85 N.E./2; 86 S.E./4; 86 S.W./2; 86 S.E./2; 105 N.E./4; 106 N.W./4; 106 N.E./4; 106 S.W./4; S.E./3, and 107 N.W./2 (in one); 106 S.E./183; 106 N.W./1; 106 S.E./4 and 107 N.E./2 (in one); 107 S.E./1; 107 S.E./2; 107 S.W./3; 107 S.W./2; 107 S.W./4; 108 N.E./3; 108 N.W./1; 108 N.W./4; 108 N.W./3; 108 N.W./2; 128 N.E./4; 128 S.W./4 and 129 N.W./2 (in one); 128 S.W./3; 129 N.W./1 and 2; 129 N.W./3; 130 N.E./3; 130 N.W./4; 130 S.W./3	4=1	29	
Chanda District, Sheets Nos. 122 N.W./4 and S.W./2 (in one); 122 S.W./3 and 4; 123 S.W./1 and 2; 123 S.W./3 and 4; 123 N.W./1 and 2; and 123 N.W./3 and 4	4=1	6	
Bhandara District, Sheets Nos. 92 N.E./2; 92 N.E./3; 92 N.W./3; 92 N.W./4; 92 S.E./1; 92 S.E./2.	4=1	6	
Raipur District, Sheets Nos. 141 N.E./4 and 164 N.W./3 (in one); 141 S.E./2 and 164 S.W./1 (in one); 187 N.E./1; 187 N.E./3; 187 N.E./4; 187 N.W./3; 187 N.W./4; 187 S.E./1; 187 S.E./3; 187 S.W./1; 187 S.W./3; 187 S.W./4; 208 N.W./1; and 208 N.W./3.	4=1	14	
Hyderabad (Deccan).			
Sheets Nos. 202, 203, 212, and 213 (in one). . . .	1=2	1	With additions to railways, etc., to April 1894.
„ „ 204, 205, 214, 215, and 222 (in one) . . .	1=2	1	With corrections to 6th October 1892.
North-Western Provinces and Oudh.			
Sheets Nos. 32, 39A., 40, 41, 56A, 57, 58, 59, 77, 78, 79, 80, 97, 98, and 160	1=1	15	
Sheet No. 146	1=1	1	2nd edition.
Punjab.			
Bashahr State, Sheets Nos. 347 N.W./1; 347 N.W./4; and 347 N.E./4	4=1	3	
Sheets Nos. 290 N. W. and 290 S. E.	2=1	2	
Sheet No. 312 S. W.	2=1	1	Preliminary edition.
„ „ 214	1=1	1	

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—*contd.*	In. M.		
North-Eastern Frontier.			
Sheet No. 22N.W.	1=4	1	3rd edition.
Sheet No. 23S.W.	1=4	1	8th edition.
Sheet No. 23N.W.	1=4	1	7th edition.
Sheet No. 15	1=8	1	3rd edition.
Sheet No. 22	1=8	1	5th edition.
South-Eastern Frontier.			
Sheet No. 1S.W.	1=4	1	4th edition.
Sheet No. 4N.E.	1=4	1	5th edition.
Sheet No. 4S.E.	1=4	1	4th edition.
Sheet No. 4S.W.	1=4	1	7th edition.
Sheet No. 1	1=8	1	4th edition.
Sheet No. 3	1=8	1	2nd edition.
Sheet No. 7	1=8	1	2nd edition.
Plans of Cities and Cantonments.			
Calcutta:—Sheets Nos. G1, G2, G3, G4, H2, H3, H4, H5, H6, H7, I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, J5, J9, J10, J11, K3, K11, K12, K13, L1, L2, L3, L4, L5, L14, L15, M2, M5, M7, M8, M9, M10, N1, N3, N4, N9, N10, N11, N12, N13, N14, N15, N16, N17, O4, O11, O12, O13, O14, O15, O16, O17, O18, P1, P3, P8, P12, P13, P14, P15, P16, P17, P18, P19, Q4, Q6, Q7, Q8, Q10, Q11, Q13, Q14, Q16, Q17, Q18, Q19, Q20, R1, R11, R13, R14, R15, R17, R18, R19, R20, R21, R22, S1, S2, S3, S4, S5, S10, S11, S12, S13, S14, S15, S17, S18, S19, T1, T2, T3, T4, T7, T8, T9, T11, T12, T13, T14, T15, U4, U5, U6, & U7	105·6=1	128	
Quetta Civil Station	16=1	2	2nd edition.
Kolhapur City and Environs	8=1	2	
Mandalay and Environs (with boundaries)	1=1	1	Extract from Sheets Nos. 260 and 261 of Upper Burma Survey.
Mandalay and Environs (without boundaries)	1=1	1	
Index Maps.			
Relative positions of Gold Mining and Prospecting grants, District Katha	1=2	1	
Forest reserves, Jhansi District	1=2½	1	
Central Provinces	...	1	
Forest surveys in Kheri and Pilibhit Districts	1=8	1	
Forest surveys in Narsingpur Division	1=8	1	
Forest surveys in Balaghat Division	1=8	1	
Forest surveys in the Pyinmana District	1=8	1	
Forest surveys in Chhindwara, Seoni, and Nagpur-Wardha Divisions	1=16	1	
Forest surveys in the Tennaserim Circle	1=32	1	
Statistical Maps.			
India showing Rice cultivation	1=64	2	
„ showing Cotton cultivation	1=64	2	
„ showing Sugarcane cultivation	1=64	2	
„ showing Railways	1=96	1	Corrected to 31st March 1894.
Administration Report Maps.			
Agra	1=8	1	
Ajmere	1=8	1	
Akola	1=8	1	
Aligarh	1=8	1	
Allahabad	1=8	1	
Amraoti	1=8	1	
Banda	1=8	1	
Basti	1=8	1	
Bara Banki	1=8	1	
Benares	1=8	1	
Bareilly	1=8	1	
Bulandshahr	1=8	1	
Bassein	1=8	1	

Title.	Scale.	Number of Sheets.	Remarks.
Administration Report Maps—*contd.*	In. M.		
Bijnor	1=8	1	
Buldana	1=8	1	
Budaon	1=8	1	
Champaran	1=8	1	
Cachar	1=8	1	
Cawnpur	1=8	1	
Dehra Dun	1=8	1	
Ellichpur	1=8	1	
Etawah	1=8	1	
Faridpur	1=8	1	
Farukhabad	1=8	1	
Fatehpur	1=8	1	
Fyzabad	1=8	1	
Gonda	1=8	1	
Gorakhpur	1=8	1	
Goalpara	1=8	1	
Hamirpur	1=8	1	
Hazaribagh	1=8	1	
Hardoi	1=8	1	
Jhansi	1=8	1	
Kheri	1=8	1	
Mainpuri	1=8	1	
Merwara	1=8	1	
Muzaffarpur	1=8	1	
Murshidabad	1=8	1	
Pilibhit	1=8	1	
Puri	1=8	1	
Rai Bareilly	1=8	1	
Saharanpur	1=8	1	
Sitapur	1=8	1	
Sylhet	1=8	1	
Wun	1=8	1	
Lohardagga	1=16	1	
North-West Provinces and Oudh	1=32	1	April 1893.
Skeleton Map of the Punjab and surrounding countries	1=32	1	With corrections and additions to railways and canals to September 1892.
Miscellaneous.			
Sheet No. 1, Gold Mining grants (near Kyauk Paya) Katha District, Burma	8=1	1	
Sheet No. 2., Gold Mining reserve (on Na Man Chaung Katha District, Burma	8=1	1	
Sheet No. 3, Gold Mining grants (near Leksaw), Katha District, Burma	8=1	1	
Sheet No. 4, Kyaukpazat Prospecting grant (near Padengon), Katha District, Burma	8=1	1	
Sheet No. 5, Man Daw Prospecting grant (near Pin Lon), Katha District, Burma	8=1	1	
Anaimali Reserved Forests, Udamalpet and Pollachi Taluks, Coimbatore District, Madras	4=1	16	
Ayyalur Reserved Forests, Dindigul and Melur Taluks, Madura District, Madras	4=1	5	
Coimbatore Reserved Forests, Coimbatore and Satyamangalam Taluks, Coimbatore District, Madras	4=1	14	
Kodangikuttu and Sendurai Reserved Forests, Melur Taluk, Madura District, Madras	4=1	1	
Konarankimalai Reserved Forest, Palni Taluk, Madura District, Madras	4=1	1	
Nagamalai Reserved Forests, Dindigul, Madura, and Tirumangalam Taluks, Madura District, Madras	4=1	2	
Nagaramalai Reserved Forests, Salem Taluk, Salem District, Madras	4=1	1	
Nallativanpati Reserved Forests, Tirumangalam Taluk, Madura District, Madras	4=1	1	
Nadumandulam Reserved Forests, Melur Taluk, Madura District, Madras	4=1	1	
Palni Hills, Northern slopes, West Reserved Forest, Palni Taluk, Madura District, Madras	4=1	1	
Rangamalai Reserved Forest, Dindigal Taluk, Madura District, Madras	4=1	1	
Rajadani Reserved Forest, Dindigal Taluk, Madura District, Madras	4=1	1	
Shevaroy Hills Reserved Forests, Salem Taluk and District, Madras	4=1	6	
Tekadi Leased Forest, Palghat Taluk, Malabar District, Madras	4=1	2	
Sireemalai Reserved Forest, Dindigul Taluk, Madura District, Madras	4=1	1	

TITLE.	Scale.	Number of Sheets.	REMARKS.
MISCELLANEOUS—*contd.*	In. M.		
Apalchand and Malhati, Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	2	
Bhalka Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	2	
Bhutri Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	1	
Boraghar North Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	1	
Boraghar South Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	2	
Buxa Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	6	
Dalgaon Forest Reserve, Jalpaiguri Sub-Division, and District, Bengal	4=1	1	
Dhumpara Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	1	
Diana Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	3	
Dumchi Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	1	
Gobur Basra Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	2	
Gosainhat and Salbari Forest Reserves, Jalpaiguri Sub-Division and District, Bengal	4=1	1	
Khairbari Forest Reserve, Jalpaiguri, Sub-Division and District, Bengal	4=1	1	
Maraghat Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	2	
Raydak Forest Reserve, Buxa Sub-Division, Jalpaiguri District, Bengal	4=1	2	
Rehti Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	1	
Salkumar Forest Reserve, Buxa Division, Jalpaiguri District, Bengal	4=1	1	
Titi Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	2	
Lower Tondu and Khairanti Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	2	
Upper Tondu Forest Reserve, Jalpaiguri Sub-Division and District, Bengal	4=1	3	
Aden (Part of Arabia)	1=4	1	
Panoramic Profile of the hill ranges seen from Simla	1=32	1	
TRIANGULATION CHARTS.			
Mandalay series, season 1892-93	1=4	1	Preliminary edition.
Madras Forest, Coimbatore Taluk and District, season 1890-91	1=2	1	
Madras Forest, Udamalpet and Pollachi Taluks, Coimbatore District, seasons 1890-92	1=2	1	

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

BURMA AND THE INDUS DELTA COAST.

Statement of the outturn of work executed by No. 24 Party during Season 1893-94.

UPPER BURMA TRIANGULATION.

DESCRIPTION OF DETAILS.	Principal Triangulation.	Secondary Triangulation.
Number of stations newly fixed	6	5
,, figures completed	3	5
Length of series in miles completed	90	...
,, approximate series in miles in advance	20	...
Area of triangulation in square miles	1480	...
Average triangular error in seconds	0″·40	0″·85
Astronomical azimuth of verification	2	...
Average probable error of angles in seconds	0″·21	...
Number of principal stations selected in advance	2	...
,, station platforms constructed	8	5
,, stations placed under official protection	11	...
,, ,, the elements of which have been computed	6	5
Area embraced by the triangulation to points exterior to main triangulation in square miles	350	...
Number of points fixed by intersection but not visited	3	...
,, stations and points the heights of which have been determined	9	5
Number of miles of rays and paths cleared	20	...
,, preliminary charts of triangulation	1	...
,, hill tops cleared of jungle	3	2

INDUS DELTA COAST. TRIANGULATION.

DESCRIPTION OF DETAILS.	Secondary Triangulation.
Number of secondary stations newly fixed	24
Length of series in miles completed	70
Area of triangulation in square miles	470
Average triangular error in seconds	8
Linear error in feet per mile	0·37
,, ,, ,, (Intersected points)	0·11
Number of points fixed by intersection but not visited	20
,, stations and points the heights of which have been determined	41
,, beacons erected	30

INDUS DELTA COAST TRIANGULATION.

Extract from the Narrative Report of MR. P. F. PRUNTY, *Extra Assistant Superintendent, No. 24 Party, on the* INDUS DELTA COAST TRIANGULATION, *Season 1893-94.*

The programme consisted in erecting and fixing beacons at the mouths of the Indus from Karachi to the Kori creek in Cutch.

From the 3rd until the 17th November 1893 I was occupied in the vicinity of Karachi making arrangements for boats, water casks, wood for the beacons, coolies for their erection, etc., etc., as nothing is procurable along the coast line, and all supplies had to be laid in at Karachi. The Port Officer at Karachi was instructed by the Director of Indian Marine to supply me with a steam launch, as it was considered unsafe and hazardous to embark on the season's work without having a launch as an auxiliary to the country boats.

The steam launch "Repulse" lent to the detachment in the first instance was a good and serviceable boat, and rendered great help to the work, but after using her for about two months, she was replaced by the "Hazel," a small boat quite unfit for the rough work she was required to perform along the coast, or even in the creeks, or crossing over the treacherous mouths of the Indus. As there was no other launch forthcoming, I had to make the best of this one—her average speed being about 2 knots an hour, and my work was in consequence very much delayed. In the early part of March 1894, the Port Officer wrote to say that he considered it unsafe for this launch to remain out any longer and requested me to return her into port. I was subsequently informed that she had been condemned as unfit and unsafe for further use.

By the 18th November I was ready to start from Karachi but a cyclonic disturbance which had just taken place all along the coast prevented me for several days from getting out of the harbour, but once out I proceeded down the coast for 40 miles, reconnoitring the country as I went along, landing whenever practicable and selecting sites for the beacons.

Having determined on the sites for several beacons, I had the spars, material, etc., brought out from Karachi and started the work of erecting them. As the coast line swarms with white ants I was strongly advised by the Port Engineer of Karachi to use masonry foundations for the beacons, if I wanted them to last any time. As the beacons from Karachi to the Indus are intended to last ten years, and the remaining ones four years, I decided to take this precaution to ensure their permanency. This necessitated making further arrangements for lime and concrete, as the original idea was simply to sink the beacons into the earth, and hold them by logs and struts.

Eighteen beacons extending from Karachi to the Indus have been sunk in masonry concrete foundations 7 feet deep, and secured by 4 cable (wire) ropes embedded 3 feet in lime concrete and anchored at the base by a grappling iron and log of wood. The remainder of the beacons, which are of secondary importance, have been embedded 10 feet in the ground, and secured by wire guy ropes buried 5 feet and anchored by a grappling iron and log of wood. The beacons stand 40 feet above the ground and have two cross-pieces of wood 10 feet long attached to the spar 6 feet from the top, and forming two crosses at right angles to each other. The beacons are painted white and are visible from 8 to 10 miles out at sea. The sites on which the beacons are situated are above the present influence of the tides, and there is every reason to hope that they will last until the wood decays from ordinary causes.

After sufficient sites were selected for the beacon work to go on, I devoted myself to laying out the triangulation for determining their positions. This was a very difficult and irksome task, owing to the swampy nature of the country, which is perfectly flat and intersected by innumerable creeks all more or less fringed with dense mangrove forest.

By the end of February 17 beacons had been erected, extending from Karachi, a distance of about 90 miles along the coast, and stations selected for fixing them. As haze was beginning to set in and fearing its consequences if I postponed the observations any longer, I resolved to start them at once; but to enable me to do so I had to break my establishment up into squads, and send my recorder on ahead with the carpenter, mason, and a contingent of coolies to supervise the erection of the remainder of the beacons. Having made every arrangement for the onward work, I commenced the observations. The theodolite was mounted on a trestle 10 feet high, and this, with the height of its stand (5 feet), gave me an elevation of 15 feet above the ground, and a fairly good command of the surrounding country. It was very difficult to keep the instrument level during the observations, as the high trestle on which the theodolite was perched vibrated terribly through the violence of the wind and the soft yielding soil on which it stood.

On the 20th April the haze became so dense as to obstruct all vision, and I was compelled to close work.

Observations have been taken at 25 stations, fixing the position of 17 beacons along the coast from Karachi, and of four other points in the Karachi Harbour, *viz*, the lighthouse, signal flag staff, and red light beacon at Manora, and a Harbour beacon on the Chino creek. Thirty beacons have been erected during the season, of which the positions of 13 remain to be fixed by triangulation. If a good steam launch is provided, and if the weather is fair, this should not occupy more than from two to three months of the early part of next field season.

Nothing is procurable for 180 miles along the coast from Karachi to the Kori creek in Cutch. Everything has to be imported from Karachi by boat, in the way of material, labour and the necessaries of life, and even drinking water (the source of the greatest anxiety to me throughout the field season) had to be brought from a distance or 80 miles, until the mouths of the Indus were struck near Keti Bandar. The supply of water was as uncertain as the weather, and the whole camp has frequently felt the pangs of drought, notwithstanding the precaution of doling out the scanty daily ration of 2 *lotas* per man.

The climate is very unhealthy and malarious and the health of the establishment was bad for the greater part of the season; fever attacked us at the start, and for two months after entering the delta there was hardly a man fit for work.

The coast line is very much broken, and consists of a narrow strip of shiftings and about a quarter of a mile in breadth: all the country for 10 to 15 miles inland, is swamp, intersected by numberless creeks

The present mouths of the Indus extend from a few miles south-west of Keti Bandar to the Mull river, some 30 miles south-east. The Hajámaro river, once one of the main channels of the Indus, has dwindled down into an insignificant creek, about 1 mile in length. The water of this river has found a course miles away from its former bed, and has changed all the features of the country around the locality where it now wanders.

BALUCHISTAN.

NOTES ON THE ANTIQUITIES, ETHNOGRAPHY AND HISTORY OF LAS BELA AND MAKRÁN

By COLONEL T. H. HOLDICH, C.B., C.I.E., R.E., *Superintendent, 1st Grade, in charge No. 15 Party, Season 1893-94.*

The field work of the last two seasons has resulted in considerable additions to our knowledge both of the ethnography and of the history of Makrán, and a short summary of these results is herewith appended.

Sutkagen Dor.

2. Mr. Wainright found an opportunity of visiting the ruins at Sutkagen Dor about 40 miles north-west of Gwadar in the winter of 1892-93, but his cursory examination of them has thrown little new light on their origin or intention. The series of stone paved platforms bounded by walls nearly 2 feet thick and evidently once connected with a gigantic bund 25 feet thick built of massive stones between two low hills which form an artficial protection against the floods of the river Dasht, is conjectured by Major Mockler to have been a temple, although local tradition points to its having served as a "bunder" in days when the sea reached far up the delta of the Dasht. The existence of buildings built of burnt brick in its vicinity and the remains of the second platform, of which the underneath layers are formed of burnt brick 7 feet above the first, certainly might seem to connect it wth the ancient "ziggaruts" or temples erected by those pre-Semitic races that peopled lower Mesopotamia, and of which the famous Birs Nimrud near Babylon is the most celebrated example. This would carry us far back to the days of sun and planet worship, when, as Nearkos tells us, the island of Astola on the Makran coast was sacred to the sun, many centuries before the Christian era. The existence of masses of burnt brick in connection not only with this possible "ziggarut" but with those remarkable collections of dwellings and tombs called "dambs," is a curious feature which deserves the attention of antiquarians in connection with the universal use of burnt brick in ancient Mesopotamia, even in districts where stone was readily available. Nevertheless local evidence is strongly in favour of Sutkagen Dor having been nothing more than a "bunder" or "ghat" in the days when the Dasht was navigable up to this point. There are even traditions of its having served as the landing place of a Portuguese force which carried the adjacent fort by stratagem, the soldiers being introduced within the walls concealed in bales of goods. A Portuguese coin too has lately been found in the fort, which seems to confirm the local story. Whatever may have been the history of these remarkable ruins in the dim past, there can be little doubt that within historic times Sutkagen Dor has been a seaport.

The "Dambs."

3. There is little or nothing to add to the records of those other adjacent ruins, the "Dambs" of Damba Koh. Those small buildings which cover the hill sides in Makrán in some parts of the district known as Damb, are invariably built of slabs of limestone, or calcareous sandstone, found by the builders "ready cut by the hand of nature on the hill sides," and subsequently cemented with mud.

4. They are conjectured by Colonel Mockler, on the evidence of excavated bones, to have been the tombs or sepulchres of the people who dwelt in the more elaborate stone built houses which crowd themselves into small townships on neighbouring hills and plains. Many of these houses were opened and examined, and Colonel Mockler has not the slightest doubt that they belong to the same era as the "Dambs" and are the remains, in fact, of the city whose inhabitants deposited their dead in the "Dambs." But on the adjacent plains below them, was the evidence of an ancient brick kiln, and of masses of débris, to

support the fact that "the greater part of the town on the plain below was built of burnt brick," although all trace of it "had been effaced by water owing to the heavy floods with which the plains had been inundated." At Sutkagen Dor indeed there are the "actual remains of a burnt brick house," and further examination shews that burnt brick was largely used in this neighbourhood and was probably the chief constructive material. Within historical times and in adjacent regions, sun-dried brick and puddled mud are the universal resource of builders, as for instance in the case of the Kaiani cities and citadels in the Helmund valley, and it is certainly strange that in a district where for all time limestone has been obtrusively abundant, the early artificers of the Damba Koh houses should have troubled themselves to prepare burnt bricks. Here again is apparently another link in the connection, faintly traced before, between Lower Mesopotamia and Makrán. What became of the early Accadian brick-builders of Mesopotamia? Is it possible that they were driven southward by Semitic immigration? Or does this point to the human tide rolling in the opposite direction, and support the theory that the earliest forms of civilization entered Mesopotamia from the south, coming up from the Persian Gulf with the fishgod "Oannes," as the Accadian legends tell us? One thing seems pretty certain. We must abandon the theory of a Phœnician origin for the Damba Koh, unless indeed we are prepared to abandon also a Semitic origin for the Phœnicians themselves. The builders of the Dambs are connected by local tradition with the Turanian races of southern India, and the general tendency of all recently collected evidence on the subject of their early constructions is in support of the local traditions. One small link further may be suggested in the chain connecting the Damb builders with the early Turanian inhabitants of Mesopotamia rather than with the later Semitic settlers. They occasionally buried their dead (as Colonel Mockler tells us; for we have found no additional evidence lately) in earthen pots. I know of no other examples of this very original form of sepulture nearer than Warka (the ancient Erech) of Mesopotamia. There, indeed, the extent of the burial grounds, and the depths at which the coffins lie (600 feet below the surface of the ground in some cases) testifies that it is the most ancient of all forms of Chaldæan burial. Further than this we have no new grounds for speculation about the Damba Koh.*

5. During last winter I took some pains to discover whether at the present time there is any trace in Makrán of those Asiatic Ethiopians of whom Herodotus wrote as being inhabitants of the fourteenth and seventeenth satrapies of the Persian empire, 500 years B. C., and who were subject to Persia in the days of Darius Hystaspes. This is of interest in connection with the still vexed question whether the earliest immigrants into Mesopotamia, those people who, according to Accadian tradition brought with them from the south the science of civilization, were a Semitic race, or Kushites, descendants of Ham. It is quite impossible to ignore the early existence of Kushite races in the east as well as the south. We have not only the authority of the earliest Greek poets and historians, but Biblical records as well in support of the fact, and modern interest only centres on the question what has become of them. Below suggests that it was after these various Kush-Kash-Kach-Kuj or Kaj tribes, that certain districts of Baluchistan are named Kach Gandava and Kach Makrán; and that the chief of these tribes were the Gadara, after whom the country was called Gadrosia by the Greeks. It was thus a matter of some interest to discover whether the Gadurs of Las Bela exhibited any Ethiopian traits. But the Gadurs proved to be a section of the Rajput clan of Lumris, and probably the oldest section of that clan, holding themselves aloof from other sections, and never intermarrying with them. There could be no mistake about the Rajput origin of the red-skinned people whom both Mr. Wainright and I interviewed. They were pure Kshatryas of the lunar race; but it is probable that they represent the Gadrosii even though they are not descendants of Kush. The other Rajput tribes with whom they now coalesce have apparently held their tenure of the district of Las from so remote a period that they may well be the Oritœ of Arrian's history; the people who with the Gadrosii disputed Alexander's passage through the mountains west of the Arabius and who called their capital city by the essentially Hindu name of Rambakia. But though I failed to discover the Kushite, it does not follow that he has died out of the land. Makrán is full of an able-bodied black people with woolly hair, who are slaves and the descendants of slaves—some of whom, no doubt, are importations from the coast of Africa, but others are bred in the slave villages of the Arabian sea coast, and have been so for centuries. These are now Asiatic negroes rather than Asiatic Ethiopians, but the blood of Kush may be amongst them all the same, a weak infusion from long descent, and overlaid by all the physical characteristics of the Negro. They are a fine well-developed race of people, and some of the finest physical specimens may be found as stokers in the P. and O. Company's service.

6. Next in order of chronological interest are the stone-built ruins of Gondakehat, about 11 miles to the north-west of Las Bela on the right bank of the Kud stream. They are described by Mr. Wainright, who visited them last winter, as consisting of "detached portions of stone walls of great age, evidently remains of a fortified camp or strong-hold of no small extent.

Gondakeha.

* Since writing this I find the following in the introduction to Fergusson's History of India Architecture:—
"Geographically, however, one thing seems tolerably clear. If the Dravidians came into India in historical times, it was not from Central Asia that they migrated, but from Babylonia or some such southern region of the Asiatic continent."

Amongst these ruins two circular enclosures bounded by walls of massive stones were found. The walls were 4 feet to 5 feet high and about 4 feet wide. The enclosure is entered by an opening 3 feet wide, facing due east. A few pieces of stone-like pottery were found, but no upright altar stone or any relics were discovered by digging about the centre of the enclosure. The extent and appearance of these ruins point to their being very ancient and of considerable importance—no modern name is given to them." It is impossible to say what these ruins represent. The stones used in their construction are unshaped and of great size. They are certainly far older than the remains of the mediæval Arab cities that are scattered about Makrán and the Bela district, but there is ample historic evidence that the Arabs occupied Bela many centuries before the Christian era. The ancient name of the Purali (Arabius) and of the people who lived east of the Purali, between that river and the Hab (the Arabii) so often alluded to in Arrian's History of Alexander's invasion of India, is sufficient to indicate that the Arabs were masters of this great entrance into India at least three or four centuries B. C.; and I should be more inclined to connect the ruins of Gondakeha with the early Pagan days of Arabic ascendancy when Zimbabue in Mashonaland was built, than with anything more recent.

Gondrani.

7. Next in chronological order, I should place the 'cave city' (as it is called) of Gondrani, or the Shahr-i-Rogan, about 12 miles north-west of the town of Las Bela, and beyond Gondakeha. This consists of a large number (about 300) of caves "excavated artificially in the sides of a conglomerate hill known as the Gondrani hill. They lie along both banks of a small feeder of the Kud stream. Most of the caves are of one uniform design comprising an ante and an inner chamber. The inner chambers are rectangular in shape and generally about 12′ × 10′ and a little less than 6 feet in height. The floors and sides of these caves shew that the excavation was effected by picking out each stone, rock, or pebble, and yet there are no indications of the use of iron instruments, although the chambers are strictly symmetrical, and every angle is a true right angle, whilst the floors and roofs are perfect planes. No rock carvings or traces of colour were found and nothing indicative of Buddhist origin." The above description is by Mr. Wainright. The ante chamber shewn in Mr. Wainright's plan is more or less circular in form with an opening obviously widened by the decay of the cliff front. The connecting door between the ante chamber and inner apartment is described as very narrow. The plan of these caves is recognised by Khan Bahadur Imam Sharif as similar to Buddhist caves found near Chilas (or Chiras) in northern Afghanistan, and indeed there can be no doubt about their Buddhist origin; for we find that when Chach, the usurper of the throne of Sind, passed from that country to fix the boundaries of Makrán and Kirmán in the year 2 A. H., he travelled through Armabel and made a treaty with the reigning chief, *who was a Buddhist priest*, descended from the representative of Rai Saharao, King of Hind. Thus in the middle of the eighth century Bela was clearly a Buddhist kingdom, and by the middle of the tenth we find a kingdom of Buddha placed somewhere north of Sadusan (the ancient name for Sehwan) on the right bank of the Indus in Ibn Haukel's map. It is a matter of surprise that more clearly defined Buddhist relics have not been found in this part of Baluchistan and Sind, but the districts between Bela and Sehwan, and north of that line, have yet to be examined and surveyed. They are at present occupied by the most troublesome sections of the Mingal tribe of Brahuis, themselves of clear Mongolian origin, and probably formerly Buddhists. It is worth noting, however, that there is something significant in the name of Gondrani and Gondakehar as applied to a district occupied by cave dwellers. The Gonds of Central India are themselves cave dwellers, and there is ample evidence of the former prehistoric existence of a Dravidian race in South-western Baluchistan. As Mr. Wainright remarks "the name Gondrani *might* point to an aboriginal or Gond origin for these caves, but there is nothing in common between these artificial caves and the cave dwellings found in the Kaimur range and the Sone forests of Central India, the latter being of natural formation and containing crude drawings in red ochre and stone implements. No remains whatever were found in the caves now accessible; many, however, are inaccessible owing to time wear."

Ancient sites of Bela.

8. There are certain unnamed ruins, about 8 miles north-west of Las Bela, which are described by Wainright as follows:—"These ruins are marked by two artificial mounds lying about one hundred yards apart on the right bank of the Purali river. The mounds evidently represent the site of an Arab settlement, the debris about being composed of Arab pottery of which some pieces are highly glazed. No coins were found by excavating the mounds. At the foot of the more northern of the two are indications of old dwellings, but so dilapidated by time that it is only by standing on the higher part of the plain and looking down that faint rectangular lines and blocks are discernible. The remains are extensive, but everything is flush with the plain." They are modern compared to the Gondakehar ruins, and may possibly represent a former site of the city of Bela, or Armail (Armabel). Probably the sepultures, referred to in the Gazetteers of Baluchistan as being 5 miles west of Bela, denote the cemetery of this lost city, it being obviously the usual practice of the Arab settlers of the middle ages to build their cemeteries some miles apart from their dwellings. All the Las Bela district is dotted over with these cemeteries, generally built on rising ground commanding an extensive view, and thus becoming themselves conspicuous objects in the landscape. It may be owing to this separation that whilst the cities of the

dead have absolutely disappeared from the face of the earth, their sepulchres are remarkably well preserved.

9. Another name for the Arab city of Armail or Armabel is Karabel. At least these names have been much confused in mediæval Arab geography, and have been accepted as representing the same city by modern scholars. But I think that Karabel more probably is the name that should be applied to yet another site of ancient Bela about 1½ miles east of that town and now called Karia Pir. It is possible that Armabel and Karabel existed at one and the same time, but it appears more probable that on the destruction of the one city (and all these cities have obviously been destroyed at one time or another by fire and sword) a fresh site was chosen, and the city re-built under another name (Karia Pir) is a more modern site than those north-west of the town. It is thus described by Mr. Wainright. "Karia Pir is marked by an extensive artificial mound, about 80 feet in height. The chief interest in this site lies in the frequent finds of coins. The coins found this year were all of copper and of little value. Some bore the inscription "Mahmed Khan" in Persian characters, and others were more clearly Arabic. A seal was also found. The débris consists of Arabic pottery, old iron, broken pieces of bone wristlets and a large quantity of charred bones, supposed to be human. Excavations were made here and there on this mound, and from 4 to 6 feet below the surface two large grain jars, an earthenware plate, two tiles, etc., were unearthed intact. The men of Bela say that valuable gold coins have been found here, but none were forthcoming, and nothing about these ruins points to their having been anything but a considerable Arab settlement. The legend attached to all the ruins visited this year is that they are the remains of cities destroyed by fire from heaven. Destroyed by fire, they certainly were." So many invasions of India have been planned with various success by successive Khalifs, since the first invasion in the time of Omar the 1st (about 644 A D.) till the final occupation of Sind, by Mahomed Kasim in the days of the 6th Khalif (Walid) about 712 A.D., that there is no difficulty in accounting for the successive rise and fall and the varied fortunes of any city occupying so important a strategic position as Bela, even within the limits of this single century. For all these expeditions were over land, even when supported by sea. Mahomed Kasim took Bela (or Armail) and destroyed it on his way to Sind, and as the route of Arab invasion gradually shaped itself into a great commercial highway, which existed for eight centuries, Armail was likely enough replaced by Karabel, and those other cities sprung up, of which we have yet to write. It is worth noting that in those early days when probably the high road to India was nothing like so well developed as it subsequently became, Mahomed Kasim's force, which marched through Makrân from end to end, consisted of 6,000 picked cavalry from Syria and Irak, 6,000 armed camel sowars, 3,000 infantry and a large baggage train. The siege material used for the destruction of Debal and Nirun Kot (Hyderabad) was, however, subsequently despatched by sea. The seal found by Mr. Wainright was deciphered by Mr. C. J. Lyall, and found to be comparatively modern Arabic. Karia Pir is evidently the latest of the old sites of Bela.

Karia Pir.

10. Two other sites of Arab cities were examined by Mr Wainright in the Las Bela district, and find a place in the descriptive geography of Arab writers.

Khairo Kot "lies about 10 miles north-west of Liari and 6 miles south-west of Shé. The site is marked by an extensive low red mound, the colour being due to the burnt pottery which covers the mound. This mound is situated in an extensive plain called "Rel" and directly opposite to the Hirari river, or pass, where it debouches from the Hala range into the valley of the Purali. North of the mound lie four Khalmiti tombs in fair preservation Search and excavation unearthed a number of small copper coins with Arabic inscriptions, an oblong coin with inscription too defaced to decipher, fused metal beads, a copper earring, glazed pottery, glass bangles, and pieces of delicate and bright coloured glass, but nothing intact."

Khairo Kot.

There is, I think, little difficulty in identifying Khairo Kot with the Kambali of Arab geography. The geographer Istakhri writing about 950 A.D. gives the distance from Armabel to Kambali as two days' journey and six days from Kambali to Debal.* The once celebrated port of Debal has now been identified by General Haig with a ruin covered site some 16 to 20 miles south-west of Thatta, and about 45 miles south-east of Karachi. There is very little use in assuming any arbitrary value for a day's journey as reckoned by mediæval geographers. A day's journey must be accepted literally, as it would be in Arabia at the present time, as presenting just so much distance as it was convenient or possible to travel in a day. In well-populated districts, it may mean but a few miles from place to place; in desert countries it may represent a long day's travel for a good camel, say 80 miles; elsewhere it is the distance from one halting place to another, varying indefinitely. It may even represent so many days' journey by sea, as when Debal is said to be four days from Tiz on the Makrán coast.

Ibn Haukel, who was contemporary with Istakhri and probably compared notes with him when they met in the valley of the Indus, gives another name, Yusli, for the town which is two marches from Armail, on the direct road to Debal. Thus Yusli has been

* Kambali is stated to be on the road from Debal to Makrán and not directly between Armail and Debal, thus shewing that the route to Makrán which now runs from Sonmiani was known and used habitually as well as the mere northern route.

much confounded with Kambali by modern writers, but I think the two places are distinct. Edrisi, the compiler, about the end of eleventh century, says that Kambali is two marches from Armail (which he describes as being well-peopled, with pleasant environs and rich inhabitants), and adds that it is about a mile and a half from the sea.

Yusli.

11. I had the opportunity this year of examining the coast of the Las Bela district, and the evidence of such levelling as I could carry out clearly proved that at no very distant date the sea must have reached within a mile or two of Khairo Kot, and there is no other examined site which will answer this description. Khairo Kot is close to one of the modern high roads to Bela from Karachi, but lies south of the most direct ancient route from Debal. There is a route from the Hab range to Bela, crossing the range almost directly between Debal and Bela which leads by Uthal, and west of Uthal about 1½ miles are the ruins of another Arab settlement, which may also be reckoned as two marches from Armail (or Bela). This I think may be the Yusli or Yusa which has been mistaken for Kambali owing to similarity of description.

Mr. Wainright says of these ruins (called Kalli Kot) that they are insignificant in extent. "Excavations only unearthed broken pottery, glazed and otherwise, but as the ruins lie amongst well cultivated fields they may have been extensive ones. Cultivation will in a short time cover the site entirely, as the ground about is flat."

12. One other "buried city" in connection with this season's work calls for remark, and it is probably the oldest and most important of all.

Minagar or Manhabari.

13. Both Ptolemy and the author of the Periplus speak of a Minagar or Minnagara which was the capital of Indo Skythia and somewhere near the Indus, but inland. It is quite clear, however, as Sir H. Elliott sufficiently proves, that there were two Minagaras, and that one was on the Nerbudda, and the other on the Indus, and that considerable confusion has arisen between them. The Minagar of the Nerbudda has been identified with Mandargarh, but the site of the Indus city has hitherto been unknown. With this ancient capital of Indo Skythia has been associated the Manhanari (Istakhri), Manhatara (Ibn Haukel) or Manabari (Idrisi) of the Arab geographers, and here again we are confronted with the usual difficulty of two places with similar names, there being no one site which will answer all the descriptions given. General Haig in his pamphlet on the sites of Mansura and Brahminabad shows that there was in all probability a Manjabari on the old channel of the Indus, nearly opposite the famous city of Mansura, some 40 miles or more north-east of the modern Hyderabad, which will answer certain points of Arab description; but he shows further that it could not be the Manhabari that is referred to by Ibn Haukel and Idrisi as being west of the Indus, and two days' journey from Debal on the road to Armail (Bela) and Kanazbun (identified subseqently with Panjgûr). We have now no difficulty in deciding where that road used to run, and accepting, first, General Haig's position for Debal, and next Idrisi's description of the place as "built in a hollow" with fountains and springs around it and gardens adjacent, together with the fact that the road to Manhabari from Debal "passes through the small town of Khur," there can be little doubt that the ancient Manhabari or still more ancient Minagar, stood on the present site of Mugger Pir. The "small town" of Khur may still be found not far from the Malir water works which keep Karachi supplied, and Mugger Pir is the resort of all the holiday makers in Karachi Here the sacred alligators are kept. Hence the present name, but the real name of the place, divested of its vulgar attributes, is Manja or Manga Pir. To what the affix Pir may be due which is so common throughout the Bela district I cannot tell. But the position of the Manga Pir with its encircling wall of hills (suggesting the crater of a volcano, though there is nothing volcanic about those 'recent' deposits) with the adjacent hot springs and gardens—so rare as to be almost unique in this part of the country, its convenient position with respect to the coast, and above all its most interesting remains of Arab tombs, which include some of the best specimens in Sind or Baluchistan, mark it most unmistakeably as the Manhabari of Idrisi, "two days from Debal on the road to Armail, or to Makrán."

14. Here then our tale of buried cities unearthed during last cold weather comes to an end; but with the modern maps of Makrán before us, and one part of the mediæval map thus made plain, together with what we know of the changes of the Makrán coast configuration, and with Mr. Wainright's description of ancient sites in western Makrán and eastern Persia, we have now no difficulty in unfolding the entire record of this marvellous mediæval geographical system, a record which places Makrán in a curious light as the "open sesame" of India; the connecting passage between west and east. For these cities were not obscure and unknown provincial towns. Wherever the Arabic language was spoken (which was over nearly all the old world), their names were known, and the reputation of their citizens and merchants as fair and straight dealing people or otherwise, was as much discussed by travellers, merchants, and politicians as doubtless was the state of the roads and the means of transport over them.

15. A passing reference has been made to one of the great cities of Makrán, the greatest probably and the first on the road from Armail through Makrán to Persia.

Owing to the looseness of Arabic orthography and habitual carelessness of Arab writers as regards diacritical marks, the name of this place has come to be written in a great variety of ways.

16. Kannazbur, Kinnazbur, Kabryun, Firbuz, etc., all represent the same place, as the constant reiteration of its distance from Armail on the Makrán high road testifies. It was a large city (as large, we are told, as the celebrated city of Mansura which covered at least two square miles of country), but not so large as Kir (Kiz, Kej) which according to Idrisi was as large as Multan.

Kanazbur.

Of Firbuz he says that "the inhabitants are rich. They carry on a good trade; they are men of their word and enemies of fraud, and they are generous and charitable."

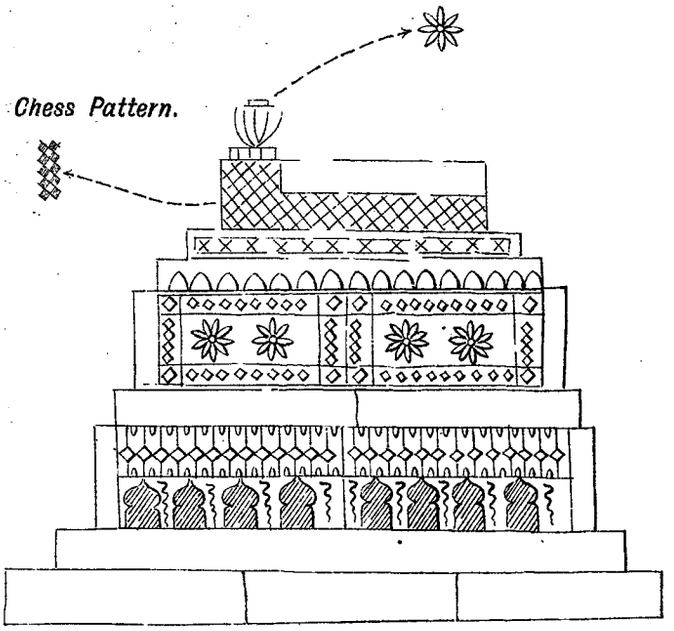
17. Sir H. Elliott rightly conjectures that Firabuz or Kannazbur is somewhere in the neighbourhood of Panjgur. It is in fact on the one great highway which traverses Makrán, and has traversed it from time immemorial. Kannazbur existed long before the days of Mohamed Kasim's invasion of Sind and of Arab ascendancy in Makrán, for we read that the great king Chach of Sind, when he passed through Makrán *en route* to Kirmán in the year 2 A. H. to settle its boundaries, built a fort there, and caused a *naubat* of instruments to be played in the fort morning and evening. The fort of Chach has long disappeared, but there is a comparatively new fort built by the Naoshirwanis at a place, called Khudabadan near Panjgur (which is a name dating from the sixth century) which may very well represent the site of the old one. The most extensive date groves of Makrán are to be found near here, and a fairly wide extent of cultivation is still maintained by Karez irrigation. It is an important position, and must always have been so, and there are traces of irrigation works on such a gigantic scale in the neighbourhood as to prove it to have once been the centre of a large population.

18. But we cannot follow mediæval geography further into Makrán. In connection with last season's survey one antiquarian point of interest still remains to be noted, and it is one which has a wide interest through Sind and Makrán. Reference has already been made to the singular tombs which are found in groups in the districts stretching from Karachi to Bela, and which are generally known as "Khalmati." They are far too conspicuous a feature in the landscape to be overlooked even by the most cursory traveller. Groups of them may be seen at Malir, near the Karachi water-works; at Mugger (or Manja) Pir; and again on the road to Sonmiani and Makrán, whilst there is hardly an Arabic settlement in the Las Bela district, of which the site has been traced, which has not, somewhere in the near neighbourhood, a sepulchral record of its dead citizens. Generally placed on rising ground, with a fair command of the surrounding landscape, they are the most conspicuous witnesses yet remaining of the nature of that Saracenic architecture which must have beautified these early cities. Possibly their distance from the town has helped to preserve them in the days of ruthless slaughter and destruction; more probably their witness in solid stone engraving to the faith of Islam (no matter how perverted) has saved them from successive Mahomedan destroyers; or indeed it may be possible that whilst the cities themselves have never been re-built or have revived in sites far apart from their ancient foundations, these sepulchres have been still erected over dead Moslems buried in their traditionally sacred places.

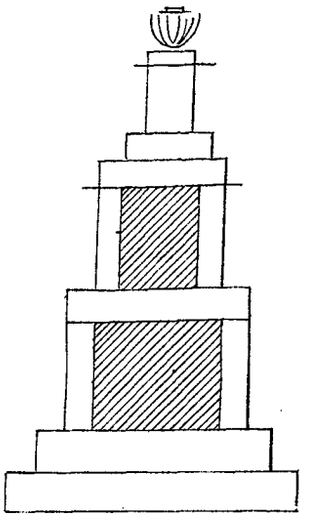
The Kharmati Tombs, *vide* illustration.

19. However that may be, the preservation of the tombs and the delicate carvings which embellish them is marvellous; and even giving all consideration to the favourable nature of the almost rainless climate of that part of the frontier, it seems impossible to believe that many centuries can have elapsed since the deep square-edged carvings of the superstructure left the carvers' hands.

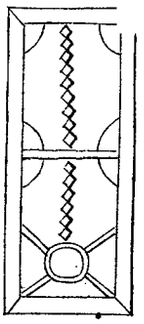
20. This superstructure, which is raised over the grave, consists of two oblong stone enclosures placed one above the other, the upper being smaller than the one below, and both resting on plinths formed of flat slabs of stone. Above the upper one is usually a single slab set lengthways on edge, and surmounted at one end with a solid floral decoration which probably denotes the position of the head of the buried Moslem below, and may be meant to represent a turban, but is usually more suggestive of a pumpkin or a conventional flower of the lotus species. As is the case in all Mohamedan decorative art, no living figure, even in the most conventional form, is introduced. The patterns deeply engraved on the sides of the upright slabs are all either purely geometrical, or they are relieved by the conventional lotus, or rosette, which is a prominent feature throughout. The Saracenic arch is a very conspicuous feature. Two tombs set side by side frequently denote the resting place of a man and his wife, the woman's tomb being the smaller, and generally distinguished by the introduction of bangles and anklets into the carved decoration. Occasionally a pair are placed on a high platform three or four feet above ground level, and are protected by a domed roof supported on pillars, denoting that a departed chief of wealth and importance lies below. No inscriptions were found on any of them except the simple record of a name on one, which, from the position of it, was far more likely to be the name of the mason than that of the departed chief. Here and there a piece of ground about 50 feet square is enclosed with a masonry wall, built of well squared and neatly-fitted slabs of stone riveted together without mortar. Two parallel ranges of stone slabs, each slab being about 6 inches deep and set up on edge, neatly fitted and riveted to its neighbour, will form a wall which is about 1 foot 6 inches wide, 4 feet high, and the intermediate space between the parallel slabs being filled in with earth. The wall is surmounted by slabs placed flat. A plan and elevation are given in the adjoining plate, as well as an elevation of a well-preserved tomb with a section through it. Inside the enclosure are frequently a number of tombs of small size and insignificant proportions, degenerat-



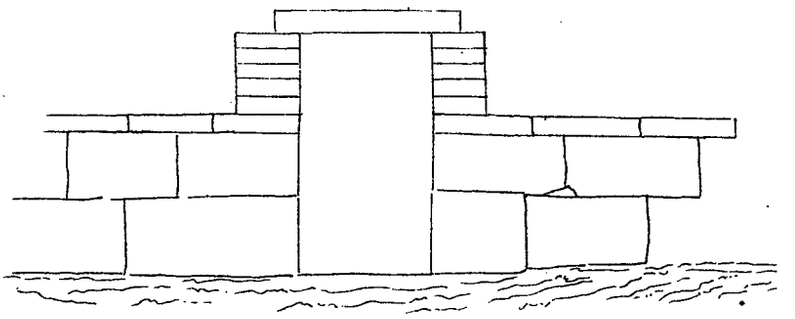
Elevation of Karmati Tomb.



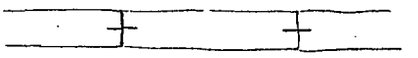
Section.



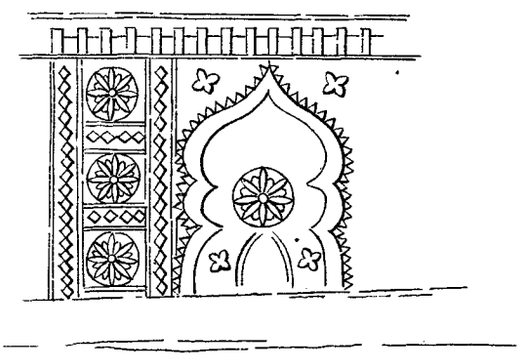
Single Slab, laid flat.

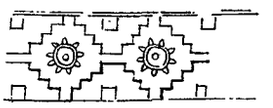


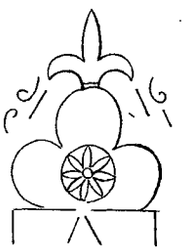
Entrance into Enclosure.

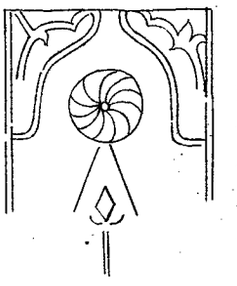


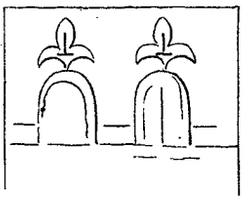
Plan of outside Slabs of Wall.











Specimens of Decoration.

Reg No. 462. S. I. D.—Sept. 94—550.

Litho., S. I. O., Calcutta

ing into mere conventional imitations of the larger structures outside. Amongst them are simple slabs laid flat with the mere outline of carved symbols in slight relief. Local tradition calls these tombs "Khalmati," in the Bela district, and asserts that those near Malir were built by Jokias. The only people now known as Khalmati are an insignificant tribe now residing in the Pasni district of Baluch Makrán, but who emigrated originally from Sind, and claim affinity with the Rind tribes, asserting that their ancestors came from Syria. They appear to have taken their name (according to Ross) from the Khalmat creek, or Khor, which is a well-known feature on the Makrán coast, and is even recorded under the name of Kalama in the log kept by Nearkos where he sailed from Karachi to the Euphrates 300 years B. C.

21. My own opinion is that they are not Khalmatis, but Kharmatis, and that they are a section of the Kharmati tribe which Mr. James (the Commissioner of Sind) tells me now inhabits the districts north-east of Karachi, including the site of the ancient Arabic city of Debal.

North-west of them lie the Jokias whose chief is entitled Jam. The chief of the Jokias and Kharmatis alike are still (according to James) principal *jaghirdars* in Sind; and the Kharmatis claim connection with Rind (or Arab) Baluchis and say that Syria was their original home. Whether the Jokias and Kharmatis claim affinity I am not at present aware. The Kharmatis are evidently the tribe mentioned by Sir H. Elliott as being the modern representatives of the ancient Kharmatian sect still existing in Sind, and their former influence in the Indus valley can be gathered from the following historical facts, chiefly taken from Elliott's History.

We hear of them first in the days when the power of the Khalifat was declining, ere the reign of Al Muktadar (A. D. 908—932), by which time the Turks were already aggressive and the Karmatian heretics first brought themselves into prominence by plundering Kufa, Basrah, and Samarrah, and even carried off the sacred black stone from Mecca. They are not mentioned by Ibn Haukel, who was in the Indus valley about the middle of the tenth century, but it could not have been very long after his time that they began to spread there, having been driven from the seat of their early conquests, and appearing in Sind chiefly as refugees from Bahrein and Al Hassa. About 985 they founded new settlements on the Indus, and shortly after were in occupation both of Mansura and Multan. Mahmud of Ghazni captured Mansura about A. D. 1036 on his return from Somnath, being already in possession of Khozdar and Multan, and thus practically ended the period of Arab ascendancy in Sind with the downfall of the Karmatians.

22. Biruni tells us that Mahmud reopened the old mosque at Multan built by the Ummayide Khalifs, which had been closed by the Karmatians when they occupied Multan, owing to their hatred of the Ummayides. They had built a new Jama' Masjid with the stones of the great Multan temple after smashing up the historical idol. Thus for a short period we see that the Karmatians were the actual rulers of Sind. They were by no means the only heretics of their time. There were such schismatics as Kharijis, Zindikis, Khwajas and Shariites, flourishing in Makrán and Sind before their days; but there is a peculiar interest attaching to the "people of the veil," as the Karmatians were called, as it is quite clear that they were in close correspondence not only with the Karmatians of Persia and Arabia, but also with the mediæval schismatics of Syria, the Ismailians or 'assassins' (Hashashin, according to Conder), the Druses, and others of those mystical sects who were all suspected of being largely indebted to the east for that mystic philosophy and theology which landed them finally in pure atheism. After the disappearance of the Karmatians from Multan, we hear little more about them, but we know that they still flourished. The Ghazni rule did not last long. It was replaced by the Sumra dynasty of Mohamedan Rajputs in 1051, and one of the Sumra Rajas, at least, was a Karmatian. The Sammar, who were also Rajput converts to Islam (about 1300), replaced the Sumras in 1351. Their chief was first entitled Jam—a title evidently derived from the Mogal "Cham," and it is rather significant that a Mohamedan title quite foreign to western India should have been assumed just at this period of Mogul ascendancy.

23. Throughout the short-lived Mogul dynasty of the Arghans, who succeeded the Sammars in 1521, and the Turkhans who followed in 1554, we hear no more of the Karmatians. Nor does Sind occupy a very prominent position in the annals of the Mogul dynasty of India; but we may safely assume that the Karmatians survived throughout the days of the Moguls, and that they may now be recognized in the Karmatis on the site of the ancient Debal. These then are the people who probably built the 'Karmati' tombs in Lower Sind and the Bela districts. It is probable that they ceased to build them with the disappearance of the old Arab settlements, cities, or towns which they occupied. The pure Arab settlers disappeared from Sind about the time that the Karmatian rule was displaced in Multan. The first Ghaznivide Governor of Sind found very few pure Arab families remaining, for by his time the descendants of the Arab troops brought into the Indus valley by Mohamed Kasim and previous invaders, were mostly merged into the progenitors of that mixed race of Rinds that now claim to have come originally from Syria. That Mahomed Kasim's troops came chiefly from Syria, we know from the message of the savage Khalif Sulaiman. "Sow and sweat for none of you will ever see *Syria*." The original Arab invaders brought no women with them, contrary to their usual custom; so they must have taken wives of the people of the

country, and although, during the two or three centuries of subsequent Arab occupations and Arab immigration, Arab women may have been freely introduced into India, yet it s clear that there must have been a large admixture of Indian blood as time went on; and amongst the scattered tribes of Rinds, who form the bulk of the population in some districts of Makrán, and on the borders of Sind, there is probably nothing like a *pucca* Arab to be found.

24. When the Arab cities of Armail, Kambali, Yusli, etc, disappeared it is impossible to say. Some of them doubtless were destroyed by Mohamed Kasim and re-built, but many of them arose subsequent to his date. It seems unlikely that the tides of invasion that set in periodically from the west after Mahmud of Ghazni set the example early in the eleventh century, passed over Makrán or Las Bela. Possibly these cities survived till a comparatively recent date. A seal has been found in one of them with a date as late as the seventeenth century, so that the freshness of the carvings on the Karmati tombs is no matter of surprise. The interest of these tombs, architecturally, lies in the fact that they belong to the "dark age" of Indian architecture. It is during the two or three centuries succeeding the Arab occupation of Sind that the art of architecture in India seems to be absolutely unillustrated. Here, however, is at least a contribution towards filling up the gap, although there is nothing in these remote Karmati tombs which can rival the interest or splendour of either previous or succeeding ages.

LATITUDE OPERATIONS.

Extract from the Narrative Report of CAPTAIN S. G. BURRARD, R. E., *in charge of No. 22 Party (Astronomical), Season 1893-94.*

The programme of work laid down for the field season 1893-94 was the continuation of latitude operations on the Jodhpore Meridional Series, and the instrument to be employed was Zenith Sector No. 1.

Observations were commenced on October 29th at Agra longitude station, where I had been directed to observe an astronomical latitude on my way to the Bikanir desert. The observations were completed on November 4th, and the party left for Bikanir on November 6th.

At Bikanir every assistance was rendered me by the State officials. I had no difficulty in procuring camels, but it was not easy to obtain carriers as the *kahár* class is almost extinct. I left Bikanir city on November 28th, and marched westward into the desert, carrying supplies for the *khalásis* with me. Ten miles over the sand is a long day's march for *kahárs*, and I took six days to do 60 miles. On December 4th I arrived at the trigonometrical station of Bithnok, which is situated on the border line between Bikanir and Jeysulmere, and about 50 miles due north of the station of Jambo, where I observed for latitude in 1892-93. Work was finished on December 10th, and the party marched north to Khirsar. The hamlet of Khirsar, mentioned by Col. Rogers in 1874, had disappeared; there was no village within a day's march, and water had to be brought daily from Poogal, a distance of 11 miles. Poogal has been in its time an important place, but has now sunk into insignificance; it formerly belonged to Jeysulmere, but is now a fief of the Bikanir Rajah. The Rao of Poogal is of the Rathor clan of Rajputs of the same family as the Maharajahs of Jodh ore and Bikanir. In 1808 Mounstuart Elphinstone, when on his mission to Cabul, marched from Delhi through Shaikhawáti and Bikanir, and halted two days at Poogal; when there he got his water from the Sutlej, a distance of 130 miles.

Observations were closed at Khirsar on December 21st, and the party marched northwards to Telu. On December 24th I reached the boundary line between Bikanir and Bahawalpur. The Rajputs of Bikanir are more attached to the soil than the Mahommedans of Bahawalpur, and the advancing sand has driven the latter before it. As the sand advances, the Rajput deepens his well, and enlarges his underground cisterns, in which he stores the rainfall of the monsoon, and it was quite the exception in Bikanir and Jodhpore to find a hamlet missing that was shown on the map. In Bahawalpur it is quite different, and from the moment of crossing the boundary the difference becomes marked. My station at Telu was four marches within the Bahawalpur boundary, and in those four marches I saw no village, no well, no human being and no track: *chinkara* antelope, and *houbara* bustard were plentiful, and there were a few ruins of former hamlets, half buried by the advancing sand. The Atlas sheet had led me to expect signs of life at every 12 or 15 miles, but except for the remains of an occasional tank, excavated perhaps a century ago, and now almost obliterated, though still holding water for a month or two after the monsoon, there was nothing to show that man had ever lived here.

The station of Telu was reached on December 28th; it is situated within 11 miles of the old town of Mojgarh, from which I was able to get water daily. Observations were closed on January 3rd 1894, and on the 5th I reached Mojgarh. This was once a large and flourishing town on the banks of the river Hukra: it possesses the remains of a strong brick fort with walls 60 feet high, and of a fine Pathan mosque, rapidly falling to pieces. The population is not a tenth of what it has been, and there are now only 100 houses In the course of another century the town will share the fate of the

surrounding villages and be buried in the sand. The few inhabitants that still remain there are held together by the presence of a well dug centuries ago, the one well in the whole country round: they make no attempt to cultivate the ground, but get their wheat from the Sutlej, and they sell in return a sub-carbonate of soda, which they obtain from a plant called *sujjee* which grows wild in the desert.

On January 6th I crossed the dry bed of the extinct river Hukra; the bed varies in width from 2 to 3 miles, and it must once have been an important channel connecting the Himalayan snows with the Arabian Sea. Sir Alexander Cunningham states that the water even now, at rare occasions, comes roaring down the Hukra, but if this is the case, it must soon be absorbed in the desert. No water has been seen in its bed at Mojgarh within the memory of living man, and though the tradition that a great river flowed here in former ages, has been handed down to the inhabitants from their ancestors, there is no record of even one flood since the days of Mahmúd of Ghazni. This river, which is also called the Ghaggar, is frequently mentioned in Hindu history prior to the Mahommedan invasions; and the battle, in which the last Hindu Emperor of Delhi was defeated, was fought on its banks. The line of fine old ruined forts, Mírgarh, Mároth, Mojgarh, Dingarh, Derawur and Khairgarh testify to the former existence of a permanent river; with its disappearance they ceased to be towns, and are now merely brick monuments in memory of the Hukra.

On January 9th I arrived at Ládimsir, my fifth station. Though distant only 10 miles from the Sutlej, it is surrounded by sandy desert. Work was completed here on January 17th, and on February 1st I reached Dera Dín Panáh, a principal station of the Great Indus Series. The party was much delayed here by constant rain and clouds, and work was not completed till February 26th. The party then moved to Mooltan, and I observed for latitude at the Mooltan longitude station, completing observations there on March 14th.

Seven stations were thus completed near the meridian of 72°. In addition to these seven I had been directed to observe for latitude at the Amritsar longitude station, where I closed work on April 5th.

Final Results.

I observed for six nights at each station, except at Bithnok and Khirsar, where water had to be brought from such long distances that I curtailed my stay and only observed four nights. At Telu also the difficulty of getting water made me anxious to move after four nights' work, but as several stars had been lost through clouds, I had to work for six nights.

The difficulty of obtaining "pairs" of stars for the Talcott method increases as one advances northward, and neither at Amritsar nor De ra Dín Panáh could I discovera sufficient number of suitable pairs. To compensate for the deficiency, I observed each pair 4 to 6 times, instead of 2 or 3 times, as ordinarily is the custom. But it is a well-established fact, that 6 observations of one pair give a less valuable result than one observation of six pairs, and the probable error at both Amritsar and Dera Din Panáh is, as I expected, larger than at any other station.

The final results of the season's work have been abstracted, and are shown in the following table:—

No.	Station.	No. of stars.	No of observation.	Astronomical latitude $=\Phi$	p. e.	Geodetic latitude $=\lambda$	$\Phi - \lambda$	
				° ′ ″		° ′ ″	″	
1	Agra	70	180	27- 9-34·52	±·063	27- 9-39·93	−5·41	N
2	Bithnok	74	180	27-53-25·04	±·053	27-53-22·03	+3·01	S
3	Khirsar	76	196	28-29-43·77	±·063	28-29-40·91	+2·86	S
4	Telu	80	192	28-56-12·42	±·046	28-56-11·34	+1·08	S
5	Ládimsir	92	262	29-21-39·84	±·061	29-21-41·58	−1·74	N
6	Mooltan	72	184	30-10 56·23	±·068	30-10-58·70	−2·47	N
7	Dera Dín Panáh	45	178	30-33-59·62	±·086	30-34- 1·87	−2·25	N
8	Amritsar	34	204	31-38- 2·53	±·078	31-37-58·72	+3·81	S

In 1892-93 I was working the Talcott method for the first time. In one way and another there is a good deal to learn in observing with a zenith telescope, and I confidently expected that my results in 1893-94 would show a marked improvement over those of 1892-93. The Talcott method of observing is so much simpler than the sector method, and the elimination of a graduated limb is such an advantage, that in 1892-93 I felt certain that my results would be better than those I had obtained in previous years, when working on the sector method. They proved, however, to be worse, and what has disappointed me more is that the results of the present season's work have a larger probable error than ever. I am quite certain that this has nothing to do with errors of intersection: I was more particular this year than I had ever been before, and as it is impossible to make the horizontal wire precisely horizontal, owing to the comparative coarseness of the adjusting screws, I always made a point of intersecting the two stars of a pair at the same identical spot on the horizontal wire.

When working on the sector method, I always regarded the level as the weakest part of the instrument, as it was inferior in accuracy both to the limb graduation and to the micrometer screw. But with the sector method the dislevelment is determined by *two* levels, and with the Talcott by only *one*. When *two* levels are used, they seldom show the same dislevelment, and a mean was always adopted. I have no doubt now, that this mean was a better value than could have been obtained from any single level, and that the presence of two levels is one of the reasons of the superiority of the sector over the zenith telescope.

With the sector it is seldom necessary to use more than 100 divisions of the micrometer screw in any one observation, and an experienced observer will work for hours without using more than 20 divisions. With the zenith telescope one cannot bring the star near the wire with the tangent screw, and the whole distance between two stars of a pair must be measured by the micrometer screw. Consequently it is not unfrequent to meet with measurements exceeding 8,000 micrometric divisions. Any error in the value of a micrometer division will be rejectaneous with the sector, where it has only to be multiplied by 100, but it is impossible to determine the value of one micrometric division with such accuracy that it can be multiplied by 8,000 without causing appreciable error. With the Talcott method it is easy to test the accuracy of the value of a micrometric division; in certain cases the distance between the two stars measured by the micrometer is positive, and in other cases negative: in the former the micrometric measurement has to be added to the mean declination, in the latter subtracted. If the value of a micrometric division were errorless, the latitude, as given by stars, where the micrometer correction is positive, should not differ appreciably from the latitude given by stars, where the micrometer correction is negative.

The value of one division of the micrometer screw in this zenith sector was determined in 1871 by Colonel W. M. Campbell at 0″·425456.

As long as the instrument was used as a sector, this value answered admirably; but in 1893, when I first worked on the Talcott method, I found that Campbell's value was too large by 0″·000058, and this year, 1893-94, I have used the value 0″·425398. But after working out all my results, I now find that this value is still too large, as is shown in the following table:—

Station.	Micrometer correction, positive.		Micrometer correction, negative.		Difference in latitude.	Apparent error in adopted value of micrometer screw.
	Mean magnitude of micrometer correction.	Seconds of latitude.	Mean magnitude of micrometer correction.	Seconds of latitude.		
Agra	+3,089	34″·42	—3,283	34″·62	—0″·20	—0″·000031
Bithnok	+2,679	25″·15	—2,240	24″·80	+0″·35	+0″·000071
Khirsar	+2,443	44″·03	—2,768	43″·29	+0″·74	+0″·000142
Telu	+2,556	12″·46	—3,062	12″·38	+0″·08	+0″·000014
Ládimsir	+2,540	40″·21	—3,422	39″·50	+0″·71	+0″·000117
Mooltan	+2,405	56″·34	—1,986	56″·09	+0″·25	+0″·000057
Dera Dín Panáh	+1,580	60″·32	—3,295	59″·44	+0″·88	+0″·000181
Amritsar	+2,813	2″·64	—2,190	2″·43	+0″·21	+0″·000042
					Mean	+0″·000078

At Ládimsir I observed more stars than at any other station, but found no decrease in the probable error. In fact my third programme of 40 stars gave values throughout uniformly larger than the final mean of all the stars observed, and my probable error would actually have been better, had I been content to observe two programmes only, and had not troubled over these 40 stars at all. The high values given by this third programme were due to the coincidence, that the micrometer correction happened by chance to be positive throughout. As Lieutenant Lenox-Conyngham has pointed out, the micrometer value varies with focus, and consequently with temperature, in amounts that have appreciable effect, when multiplied by factors varying from 2,000 to 8,000.

The probable error usually obtained with the sector method was ±0″·045, and with the Talcott method ±0″·058: this year my mean probable error is ±0″·066. I attribute the superiority of the sector method to the presence of *two* levels, and to the inappreciable effect of error in the micrometric value. The comparative inferiority of my results in 1893-94 I attribute to the deterioration of the level employed. In 1892-93, the bubble of this level could be reduced to a length of 10 divisons; in 1893-94, its bubble could not be made shorter than 50 divisions, and at any temperature below 35° Fahr. was too long to work with. It is a chloroform level, and Mr. Holmes, the maker, has explained the contraction of the liquid in the tube: the chloroform, he says, has decomposed, and the accuracy of the level been thereby impaired. For stability, for accuracy of graduation, and for rapidity of settlement these chloroform levels by Holmes are unequalled.

It should be noted that our Astronomical latitudes are not corrected for "altitude of station," as explained in Chapter IV of Colonel Clarke's Geodesy. In the plains of the Punjab this correction would generally be about —0″·04: at hill stations it would be

greater, amounting at Gúru Sikkar in Rajputana to —0″·24. I think it would be advisable to introduce this correction, firstly, because it affects every latitude with the same sign and, secondly, because we already apply more minute corrections than this.

Local Attraction in India.

In the Narrative Reports of the Astronomical parties the quantity $(\phi-\lambda)$ has generally been taken to represent the angle that the direction of gravity, owing to local attraction, makes with the normal to the mathematical surface of the earth. In accordance with this hypothesis our observers have been accustomed to estimate the value of $(\phi-\lambda)$ at their stations of observation with the assistance of maps, and to record their estimates on the spot, before any results have been computed. Their predictions, it is not surprising, generally prove wrong, but it is not very clear why their estimates should be so much more in error than those of the English observers. The English estimates seldom differed from the actual results by more than 2″, whereas it is not uncommon in our records to find a deflection of gravity of 3″ or 4″ north, where the observer has prophesied a similar amount south. In estimating the local attraction, there are two elements of uncertainty: we are ignorant of the variations in density of the matter underlying the earth's surface, and we do not know to what distance from our stations to extend our calculations. But these are difficulties not confined to India, and whilst the English observers have met with comparative success, the Indian have found their predictions so generally wrong, that the custom of estimating has practically been abandoned.

In the following table (table I) I have arranged the results of all the Indian astronomical latitudes in series of meridians and parallels. The symbols ϕ and λ denote observed astronomical latitudes and geodetic latitudes respectively, and the sign of $(\phi-\lambda)$ is determined by always deducting the geodetic value from the astronomic. Supposing at any station the quantity $(\phi-\lambda)$ to be due to local attraction only, then if $(\phi-\lambda)$ is positive the plumb line has been subjected to southerly attraction, and the zenith displaced to the north. Similarly a negative value of $(\phi-\lambda)$ denotes *northerly* attraction.

Astronomical latitudes are observed, and geodetic latitudes computed to the hundredth part of a second of arc, and the value of $(\phi-\lambda)$ can be consequently determined for every station to a like degree of accuracy; but in this Table I have omitted the decimal places. Though the probable error of an observed astronomical latitude derived from the accordance *inter se* of the several observations, is never as much as 0″·10, the probable error in any single value of ϕ is owing to local attraction not less than 2″·5. If the difference $(\phi-\lambda)$ is due to more causes than one, the refinement of decimals does not help to separate the different effects, but rather distracts the attention from coincidences, and gives a fictitious value to results. In any question involving the values of the earth's axes, results obtained from observed latitudes only must be but approximate, and no final settlement can be arrived at until the azimuths and longitudes are included.

Latitudes have been observed on two longitudinal series of triangulation—(1) the Great Longitudinal Series from Calcutta to Karachi, and (2) the series on parallel 18½° from Vizagapatam to Bombay. Observations have been taken at intervals on five meridional series, running from south to north, along the meridians of 72°, 75°, 76°, 78° and 80°, and there have been two groups of latitudes observed in Southern Burma.

Table I.

The values of $(\phi - \lambda)$, *as they stand at present.*

MERIDIAN OF 72°.

AMMEDABAD TO MOOLTAN.

Station.	Latitude.	$(\phi-\lambda)$
	° ′	″
Sonáda	23 7	— 4
Chiniána	24 7	—11
Deesa	24 15	— 8
Gúru Sikkar	24 38	— 3
Samdari	25 49	0
Thob	26 3	— 3
Chamu	26 40	+ 1
Jambo	27 17	+ 3
Bithnok	27 53	+ 3
Khirsar	28 30	+ 3
Telu	28 56	+ 1
Ládimsir	29 22	— 2
Mooltan	30 11	— 2
Dera Dín Panáh	30 34	— 2

MERIDIAN OF 75°.

MANGALORE TO KASHMIR.

Station.	Latitude.	$(\phi-\lambda)$
	° ′	″
Mangalore	12 52	+ 3
Koramúr	14 8	— 5
Hŏnavalli	14 17	— 2
Kundgol	15 15	— 1
Navalúr	15 25	— 3
Mávinhúnda	16 25	0
Majala	16 47	— 1
Khánpisura	18 45	— 8
Dhaigaon	19 31	— 4
Valvádi	20 44	— 6
Thikri	22 1	+ 1
Harnása	22 47	— 3
Deo Dongri	23 27	— 5
Aramlia	24 25	— 5
Khámor	25 45	— 4
Jetgarh	26 18	+ 2
Kewat	26 54	+ 1
Garinda	27 56	0
Rám Thal	28 30	— 1
Sawaipur	29 39	— 1
Khimúána	30 22	— 3
Sangatpur	31 18	+ 1
Amritsar	31 38	+ 4
Sháhpur	32 2	0
Murree	33 55	—20

MERIDIAN OF 76°.

ÁGAR TO LUDHIÁNA.

Station.	Latitude.	$\phi-\lambda$
	° ′	″
Gurária	24 26	0
Kánkra	25 38	— 1
Bánskh	26 50	— 6
Tásing	27 53	0
Rákhi	29 17	— 1
Isanpur	30 38	— 4

MERIDIAN OF 78°.

THE GREAT ARC, CAPE COMORIN TO DEHRA DUN.

Station.	Latitude.	$(\phi-\lambda)$
	° ′	″
Punnæ	8 9	+ 3
Kutipára	9 29	+ 2
Pachapálaiyam	11 0	+ 1
Bangalore	13 1	— 4
Pávagada	14 6	+ 5
Hŏnnúr	14 55	+ 3
Namthabad	15 6	— 1
Tuagat	16 10	— 6
Kodangal	17 8	— 4
Damargída	18 3	— 3
Voi	19 7	— 5
Badgaon	20 44	— 7
Takalkhera	21 6	— 7
Ládi	23 9	— 5
Kaliánpur	24 7	...
Pahárgarh	24 56	0
Kesri	25 47	+ 6
Usira	26 57	— 6
Agra	27 10	— 5
Noh	27 51	0
Datairi	28 44	— 6
Kaliána	29 31	— 7
Nojli	29 53	—14
Dehra	30 20	—38
Ámsot	30 22	—29
Rájpur	30 24	—47
Mussooree	30 27	—36
Banog	30 28	—33

MERIDIAN OF 80°.

PONDICHERRY TO SHÁHJAHÁNPUR.

Station.	Latitude.	$(\phi-\lambda)$
	° ′	″
Tiruvendipuram	11 45	+ 6
Madras	13 4	+ 8
Gudali	14 1	+ 1
Kistama	14 27	— 2
Darutippa	15 1	— 3
Ongole	15 30	— 4
Dánapa	15 56	0
Dhúlipalla	16 26	— 3
Niálamari	17 1	— 8
Bolíkŏnda	17 43	— 7
Rámgír	18 35	0
Burgpaili	18 54	— 4
Ankora	19 25	— 8
Díwai	19 49	— 6
Rájuli	20 13	— 4
Bhímsain	20 57	— 7
Sítápár	21 25	— 7
Tingmára	21 43	— 8
Sarandi Pat	22 13	— 5
Karaundi	23 11	+ 5
Potenda	24 37	+ 2
Pavia	25 27	+ 4
Kánákhera	25 51	+ 5
Dewarsán	26 16	+ 5
Etora	26 54	+ 5
Nimkár	27 21	0
Jarúra	28 0	— 6
Rámuápur	28 22	—11

PARALLEL OF 24°.

CALCUTTA TO KARACHI.

Station.	Longitude.	$(\phi-\lambda)$
	° ′	″
Karachi	67 4	0
Gúru Sikkar	72 49	— 3
Aramlia	75 2	— 5
Gurária	76 7	— 1
Kaliánpur	77 42	...
Rangír	79 28	— 1
Lora	80 12	+ 5
Karára	81 18	0
Gurwáni	82 20	+ 3
Huríláong	84 24	+11
Chendwár	85 29	+ 3
Malúncha	87 8	+ 1

PARALLEL OF 18½°.

BOMBAY TO VIZAGAPATAM.

Station.	Longitude.	$(\phi-\lambda)$
	° ′	″
Colába	72 51	—10
Mándvi	73 35	—3
Dhauleshvar	74 12	+1
Khánpisura	74 49	—8
Kem	75 21	—3
Kanheri	75 46	—9
Nitali	76 19	—4
Achola	77 2	—3
Bolarum	78 34	—6
Pirmulo	78 38	—5
Vánákŏnda	79 25	—7
Singáwáram	80 59	—7
Parampúdi	81 15	—6
Sánjib	82 44	—6
Waltair	83 22	—9

SOUTH BURMA.

Moulmein	97 40	+6
Mergui	98 49	+8

Every observer very soon discovers that the quantity (ϕ—λ) is partially subject to laws, and is not merely due to the accidental proximity of his station of mountain masses. The results on the meridian of 80° afford an example of the peculiarities of what we call "local attraction." An observer finds on commencing at Madras strong southerly attraction, which he attributes to the excessive density of the sub-marine strata underlying the Indian ocean; 60 miles northwards from the coast, the deflection of his plumb-line has decreased from 8″ to 1″, and at Kistama in Lat. 14° 27′ he finds a northerly attraction of 2″. This northerly attraction continues for 150 miles, till at Niálamari it is 8″, and the natural supposition would be, that a mass of more than ordinary density was being approached, that immediately over this mass gravity would act in the direction of the normal, and that on crossing it to the north southerly attraction would commence. But the northerly attraction continues for another 150 miles, and at Ankora it is still 8″; for a third length of 150 miles it continues very strongly marked, and at Lingmára it is again 8″, and there is not one positive value for (ϕ—λ) till Karaundi is reached in Lat. 23°, over 500 miles from Kistama. At two intermediate stations, it is true, the value of (ϕ—λ) is nothing, but at these stations it is only natural to conclude that the main northerly attractive force, acting throughout the series, has been compensated by some purely local and accidental source of attraction. On the Great Arc the latitude stations were 60 miles apart, and it is just conceivable, though contrary to the laws of chance, that at 16 successive stations 60 miles apart there might be some purely local source of northerly attraction, at too great a distance to cause southerly attraction at the next immediate station to the north. But on the meridian of 80°, the stations are only 30 miles apart, and this is such a small distance that any hill, causing northerly attraction at Sítápár for instance, would of necessity attract the plumb-line at Lingmára to the south.

The difference (ϕ—λ) at any station may be due to any one or more of the following causes:—

(i.) The deflection of the plumb-line, due to local disturbance of gravity.
(ii.) An error in the initial latitude at Kaliánpur, due to local attraction at that station.
(iii.) An error in the adopted initial azimuth at Kaliánpur, on which the orientation of the whole system of triangulation depends.
(iv.) Errors in the adopted values of the earth's axes.

Himalayan attraction.

From Table I it appears that on the meridian of 80° Himalayan attraction does not affect the plumb-line, south of Lat. 27° 30′. On the meridian of 78° the attraction of the Himalayas extends to Lat. 27° 51′, on that of 76° to Lat 29°, and on that of 75° to Lat. 32°. On the meridian of 72° the attraction of the Sulemán mountains is very slight at Dera Dín Panáh, and at Mooltan the apparent northerly attraction of 2″ is probably not due to these mountains, as the longitude observations show that in the prime vertical the plumb-line is deflected to the east.

The locus of points then, where the influence of the Himalayas first disappears, runs through Lucknow, Aligarh, Hánsi and Siálkot. In the west and centre of the Punjab no latitudes have been observed, except at Dera Dín Panáh and Mooltan, and the locus cannot be continued. No observations have been taken, and consequently nothing is known of the effect of Himalayan attraction between Lucknow and the Brahmaputra. Hánsi, Aligarh and Lucknow, points of no deflection, are all about 125 miles from the nearest point of the Himalayas, which in each case is situated to the north-east. By meridional measurements, Lucknow is 130 miles from the Himalayas, Aligarh 150, and Hánsi 230. But at Siálkot, also a point of no deflection, the Himalayas are only 20 miles distant meridionally. As long ago as 1867 it was pointed out by General Walker that Himalayan attraction was more fully compensated in the western than in the eastern plains, and the observations taken this year at Amritsar afford remarkable confirmation of this view. No observations have been actually taken at Siálkot, but at Amritsar, which is only 55 miles distant, there is a southerly attraction of 4″. It is certainly surprising that the influence of the Himalayas should have been so wholly compensated, for to the south and west lie flat unbroken plains. A subterranean source of attraction apparently exists in the desert around Montgomery, affecting the plumb-line at both Amritsar and Mooltan. At Amritsar the Himalayas are visible to the north-east, and any observer would predict a plumb-line deflection in that direction: but the latitude observations show southerly attraction, and the longitude observations westerly, the resultant deflection being south-west. At Mooltan the Sulemán Range is visible to the north-west, but the resultant deflection of the plumb-line is north-east. At Agra the plumb-line is apparently attracted to the north-west towards the same point near Montgomery as the plumb-lines at Amritsar and Mooltan.

The fact that Himalayan attraction on the meridian of 78° is decreased in effect by 7″ between Nojli and Kaliána, and by 15″ between Rájpur and Dehra, perhaps warrants the inference that the centre of attraction on this meridian is near the Sutlej, about 70 miles north of the foot of the hills. On the meridian of 80° the diminution of attraction between Rámuápur and Jarúra, places the centre of attraction also about 70 miles within the hills.

Sub-Oceanic attraction.

There are good reasons for believing that along the coast of India, from Bombay to Cocanada, the plumb-line is attracted towards the ocean, though in the Bay of Bengal there is no appearance of such attraction. At Bombay the coast line runs north and south, and the submarine strata can exert no influence on the plumb-line in the meridian. But if we take the three great meridional series that intersect the Indian Continent on the meridians of 75°, 78° and 80°, we find that in each case successive negative values of $(\phi-\lambda)$ continue southwards from Lat. 25°, until the coast line is approached, when a few positive values close the series. On the meridian of 75° there is northerly attraction from Lat. 25° 45′ to Lat. 14° 8′, but Mangalore, the last station, exhibits southerly attraction. On the meridian of 80° there are negative values from Lat. 22° 13′ to Lat. 14° 27′, but the three last stations, two of which are on the coast and one near it, give positive values. On the meridian of 78° the same long succession of negative values occurs, with the exception of Honnúr and Pávagada, but the extreme station of Punnœ has a southerly attraction, which would probably be greater than it is, if it were not partially compensated by the attraction of a northern mass, situated to the south of Kutipárai.

The four main arcs of longitude, that cross India proper from east to west, tend to show that the plumb-line is deflected outwards on the southern coast of India :—

Arc of longitude.	Length in miles.	Difference in the values of the arc. (Astronomic—Geodetic).
From Mooltan to Fyzabad	650	+ 4″·65
From Karachi to Calcutta	1,360	— 10″·50
From Bombay to Waltair	680	— 10″·05
From Mangalore to Madras	370	— 9″·15

Though the distance from Mangalore to Madras is much less than that from Bombay to Waltair, and only one-fourth of that from Karachi to Calcutta, the astronomic values of the three arcs are in defect of the geodetic by almost the same amount. A defect in the astronomic value of the Madras-Mangalore arc can only be caused by a deflection of the plumb-line towards the ocean, at either one or both of these stations. If the existence of sub-oceanic attraction be admitted, it would be an easy matter to find values of the earth's axes to suit the four longitude arcs, but if such attraction be denied, the results of these arcs could not be reconciled to any spheroid.

The Initial Latitude of Kaliánpur.

The most superficial observer could hardly fail to notice, from the results of Table I, how greatly in excess the negative values of $(\phi-\lambda)$ are of the positive. Even if we exclude the whole area in which Himalayan attraction shows its influence, and omit such stations as Kaliána, which have been included by Everest and Clarke, the negative values still greatly predominate throughout India. Except in a narrow belt round the southern coast, and in a zone 100 miles broad that crosses India about Lat. 25°, no positive value is to be found throughout the continent.

Excluding all stations under the influence of the Himalayas, the total algebraical sum of the remaining values of $(\phi-\lambda)$ is $-185''$ for 116 stations.

This predominance of negative values can, I think, be only explained in two ways: (i) either our adopted values of the earth's axes must be very much in error, or (ii) the initial latitude observed at Kaliánpur must have been affected by "purely local" attraction.

It is impossible of course to tell at *what* point on each meridian Himalayan attraction really ends, and when on the meridian of 78° we assume its limit is at Noh, where gravity first coincides with the normal, the absence of deflection may have been merely brought about by a counter-attraction from the south. It may be that Himalayan attraction extends much further south, and that about Lat. 26° it is merely neutralised by the Vindhyáchal and Sátpura ranges. But it is clear that to whatever distance it *does* extend, it would not tend to make $(\phi-\lambda)$ negative over the Deccan: if its influence were felt south of Lat. 24°, the initial latitude at Kaliánpur must have been affected, and every geodetic latitude diminished accordingly. If our initial station had been at Madras, a predominance of negatives might have been due to the great source of northerly attraction, but with the initial station in Central India an excess of negative values could not be so produced.

If the predominance of negative values be due to the adoption of erroneous axes, the errors in these axes must be such as would make all geodetic latitudes too large. In

other words geodetic arcs are too large north of Kaliánpur, and too small south. An arc of 1° in Lat. 27° must be too large by 0″·083, and in Lat. 16° too small by 0″·375, from which it follows that the radius of curvature in Lat. 27° is too small by 480 feet, and in Lat. 16° too large by 2,180 feet. If the radii of curvature of the Everest spheroid be corrected by these amounts, and the form of the correct spheroid computed, the results are :—

$$\text{Semi-Equatorial axis} = a = 20943512$$
$$\text{Semi-Polar axis} = b = 20859738$$
$$(a-b) = 83774$$
$$\text{Ellipticity} = \frac{1}{250}$$

These anomalous results have been deduced approximately, and are only correct to the nearest 1,000 feet; but this amount of accuracy is sufficient to show that the excess of negative values cannot be wholly due to erroneous axes.

The simplest explanation is that the plumb-line is subject at Kaliánpur to a southerly attraction, and that the initial observed latitude, and with it every geodetic latitude in India is too great. This supposition is supported by the fact, that, with the single exception of Hurílâong, which was known to be abnormal by the observer, the negative values are, as a rule, so much larger than the positive. The largest positive value of $(\phi-\lambda)$ is 8″ at Madras, which is probably due to submarine density, and the largest positive value in the interior of the continent is 6″ at Kesri: whilst these positive values are exceptional, negative values of 7″ and 8″ are common.

It will be no easy matter to determine definitely the exact amount by which the initial latitude is in error. The algebraical sum of the results at 116 stations is—185″ and the mean is—1″·5, but this mean is undoubtedly too large. The latitude stations are not grouped symmetrically round Kaliánpur as a centre, and consequently errors in the geodetic latitudes, arising from error in the elements of the figure of the earth, would not be eliminated. By successive approximations and alterations of the values of the earth's axes, I find the error in the initial latitude at Kaliánpur to be very nearly +1″·2.

The sum of the squares of the residuals in Table I, excluding 13 Himalayan stations, $=[(\phi-\lambda)^2]=2470$: if the initial latitude, and with it every value of λ, be diminished by 1″·2, the sum of the squares is 2173.

The Initial Azimuth at Kaliánpur.

If the initial azimuth at Kaliánpur be too large, the geodetic latitudes of station towards Karachi will be too large, and $(\phi-\lambda)$ be made negative: geodetic latitudes of stations towards Calcutta will be too small, and $(\phi-\lambda)$ positive. From Table I it will be seen, that on the parallel of 24°, the mean value of the seven stations east of Kaliánpur is +3″·1, and of the four stations west of Kaliánpur —2″.3. At Karachi there is possibly southerly attraction, and the fact that $(\phi-\lambda)=0$, argues, perhaps, in favor of the existence of some compensating cause, tending to increase the value of λ. No latitudes have, however, been observed on the Great Longitudinal Series between Neemuch and Karachi, and no safe conclusions can be drawn from the few results that exist at present. Throughout Southern and Eastern India and Burma observed azimuths are, as a rule, in defect of the computed, and thus corroborate generally the result of the latitudes observed on the parallel 24°.

The initial azimuth of Súranthál at Kaliánpur was not dependent, like the initial latitude, on the astronomical observations at any one station, but was deduced from the results of 63 different places. Moreover, an error of 5″ in this initial azimuth would only affect the geodetic latitude of Karachi or Calcutta by 1″. The results of the 11 observed latitudes are not entitled to the same weight as the great number of azimuths from which the initial azimuth was deduced, and if these latitudes and azimuths appear contradictory, it is more reasonable to assume that local attraction has caused errors of 2″ or 3″ in the latitudes, than that 63 observed azimuths have been liable to a mean error of 10″.

The axes of the earth.

There is no recognised criterion by which abnormal values of $(\phi-\lambda)$ may be rejected and this is the great difficulty in the way of testing which values of the axes are more probably correct.

Professor Pierce's criterion of rejection gives the following results:— including every value of $(\phi-\lambda)$ and rejecting nothing, the mean error $(=\frac{\text{prob. error}}{0{\cdot}6745})$ of ϕ is ±7″. With this mean error, Pierce's criterion rejects every value of $(\phi-\lambda)$ larger than 19″. Now, omitting all stations with a difference of 19″ and upwards, the mean error of the remainder is 4½″: with this mean error all stations with a larger difference than 12″ are rejected. A third recomputation by the criterion rejects nothing further.

But Professor Pierce's criterion is based on the Theory of Errors, and I do not think that the Theory of Errors is applicable to Indian latitudes. The differences $(\phi-\lambda)$, if

tabulated in order of magnitude, do not agree at all with the errors computed by theory, and do not conform in any way to the Probability curve.

Errors between	Nc. of errors by the theory.	No. of errors by experience.
0″ and 1″	36	20
1″ and 2″	31	12
2″ and 3″	24	15
3″ and 4″	16	16
4″ and 5″	9	13
5″ and 6″	5	14
6″ and 7″	2	10
7″ and 8″	1	11
Over 8″	1	18

The whole Theory of Errors is based on the hypothesis, that the errors are independent and accidental, but deflections of the plumb-line in India cannot be considered either one or the other.

If we find the spheroid that most nearly represents the surface of India, by making the sum of the squares of the corrections to the observed latitudes a minimum, the result will not represent the figure of the earth, nor will it conform to the plains of India.

Himalayan deflections cannot be regarded as residuals, and, I think, they should be rejected in the calculation of the earth's axes, and afterwards included in the determination of the deformations of the surface. A similar uncertainty exists with regard to stations on the coast, whether to retain them or reject them, and this is a matter of considerable importance, as the coast stations unfortunately happen to be at a greater distance from Kaliánpur than any others, and consequently have a greater influence in determining the values of the axes.

If any area is being surveyed for geodetic purposes, and at all stations on its boundary the plumb-line is attracted outwards, the locus on the celestial sphere of the zeniths of boundary stations encloses too small an astronomical area for comparison with the surveyed terrestrial area, and too large a spheroid must result. The effect of any large source of attraction in the interior of the area is neutralised, if astronomical observations are taken on all sides, but the effect of external sources of attraction cannot be compensated.

In this matter of the rejection of certain values of $(\phi - \lambda)$ it is not only a question of abnormal deflections. It frequently happens that two or more astronomical latitudes have been observed within a few miles of each other. Lieutenant Lenox-Conyngham observed a latitude at St. Thomas' Mount, and another 6 miles off at the Madras Observatory, and they both show strong southerly attraction. Should they both be included? If the correct values of the axes are to be determined by making the sum of the squares of the latitude corrections a minimum, each observed latitude will furnish one equation, and it is manifestly incorrect that the attraction at Madras should enter into two equations, whilst an area in the Punjab larger than England is unrepresented. Both at Moulmein and Mergui three latitudes were observed at small distances from one another, all exhibiting strong southerly attraction with scarcely any variation: should these three form one equation or three? At many stations of the Great Arc Colonel Herschel observed groups of four or five latitudes at surrounding points in the vicinity, and almost all the large Himalayan deflections that we know of have been obtained from one small area round Dehra Dún.

If two latitudes, observed within a small distance of one another, are to be regarded as one, what is this limiting distance to be?

The method of reduction by minimum squares might have been theoretically correct, if latitudes had been observed at small equidistant intervals and at places unaffected by external attraction, but it cannot, I think, be applied now, unless several stations are eliminated by arbitrary rejection. Where the selection of stations for latitude observation has been left to the arbitrary judgment of individuals, their rejection or retention can only be decided by the same process. If the rule be laid down that every latitude station must be included, the resulting axes will wholly depend on the places selected for observation. Pierce's criterion now rejects differences of 12″ and upwards, but we have only to create a few more stations in the Himalayas, and the criterion will reject nothing under 40″. If we were now to determine the axes of the spheroid from our existing latitude observations, the results obtained could be shortly upset by the creation of 30 new latitude stations at places like Kaliána and Madras, which are, while not showing any abnormal deflections, yet distinctly under the influence of external sources of attraction.

In the following calculations I have rejected the 13 stations, which are, with little doubt, under the influence of the Himalayas; these are Dera Dín Panáh, Murree, Isanpur, Datairi, Kaliána, Nojli, Dehra, Ámsot, Rájpur, Mussooree, Banog, Jarúra and Rámuápur.

As the attraction of sub-marine strata is not so generally acknowledged, I have not rejected any coast stations, although I am in favour of doing so, on account of the undue

influence these stations have in the determination of the axes. Out of 129 stations I have retained 116.

If the correction $+1''{\cdot}2$, for error in the initial latitude, is applied to every value of $(\phi-\lambda)$ in Table I, the following are the results:—

	The algebraical sum of the values of $(\phi-\lambda)$ is
On the meridian of 72°	$-13''$ at the 2 stations south of Kaliánpur and $+7''$ at the 11 stations north of Kaliánpur.
On the meridian of 75°	$-18''$ at 13 southern stations and $+8''$ at 11 northern stations.
On the meridian of 76°	$0''$ at 5 northern stations. (there are no southern stations).
On the meridian of 78°	$-11''$ for 14 southern stations and $+2''$ for 5 northern stations.
On the meridian of 80°	$-30''$ for 20 southern stations and $+24''$ for 6 northern stations.
On the parallel of $18\frac{1}{2}$°	$-63''$ for 15 southern stations. (there are no northern stations).

I have omitted the stations on the parallel of 24°, as this is the parallel of Kaliánpur, and consequently the latitudes of these stations are not affected by errors in the axes, nor will the values of $(\phi-\lambda)$ at these stations be altered, however much the values of the axes be corrected.

From the above results it will be seen that on each series the sum of the southern values is a negative quantity, and the sum of the northern a positive: this is at variance with what we should expect, since we have included all the stations on the southern coast, where sub-oceanic attraction has a tendency to make $(\phi-\lambda)$ positive. It is impossible to attribute this striking regularity to the accidents of local attraction, and the only conclusion is that errors in the adopted values of the axes tend to make all southern values of $(\phi-\lambda)$ negative, and all northern positive.

This conclusion is particularly interesting, as it means that Everest's second constants are more suitable to the Indian latitudes than his first constants, and that Clarke's axes are less suitable than either.

The results in Table I are those that hold, when Everest's first constants are adopted as the values of the earth's axes.

The several values of the axes of the earth are:—

	a	b	a—b	$\frac{a-b}{a}$
Everest's first constants . . .	20922932	20853375	69557	$\frac{1}{301}$
Everest's second constants . . .	20920902	20853642	67260	$\frac{1}{311}$
Clarke's axes	20926062	20855121	70941	$\frac{1}{295}$

On the hypothesis that $(\phi-\lambda)$ is due to errors in Everest's first constants, an excess of positive values north of Kaliánpur signifies that northern geodetic latitudes are too small, and an excess of negative values in the south signifies that southern geodetic latitudes are too large. In other words geodetic arcs of meridian measured from Kaliánpur, whether to the north or south, are all too small, and consequently the radii of curvature too large.

The linear measure of a meridional arc, with observed latitudes at its terminal points, gives the radius of curvature of the meridian at the middle point of the arc: so from

every observed latitude we obtain a value of the radius of curvature of the meridian at a certain latitude. If a=semi-equatorial axis, b=semi-polar axis, and r′,r″... =radii of curvature in latitudes ϕ',ϕ''..., we get 116 equations between a, b, r,′r″.. , the solution of which by least squares gives the most probable values of a and b.

In order to determine approximately the apparent errors in Everest's first constants, I have taken the means of the results by northern and by southern stations, and have obtained the following data :—

In Lat. 27° an arc of 1° is 0″·41 too small, and

In Lat. 18° an arc of 1° is 0″·35 too small.

From which it follows that the radius of curvature in Lat. 27° is too large by 2,372 feet, and in Lat. 18° too large by 2,023 feet.

The values of the axes are then given at

$$a = 20919423$$
$$b = 20850747$$
$$(a-b) = 68676$$
$$\text{Ellipticity} = \tfrac{1}{304}.$$

These axes give a smaller spheroid of revolution than Everest's, whereas Clàrke's is larger than Everest's. They are, I consider, determined with sufficient accuracy to justify the statements, (1) that, as far as the Indian latitudes are concerned, Everest's first constants appear more suitable than Clarke's axes, and (2) that Everest's second constants are more suitable than his first.

By means of General Walker's formula, given in Vol. II., G. T. Survey of India, I have calculated for every latitude station the values of $(\phi-\lambda)$, that would be given, if we recomputed the Indian triangulation (firstly) with Clarke's axes, (secondly) with the new axes, approximately determined above. I give the results in Table II. Though these new axes have been determined from the Indian latitudes only, and but approximately from them, the results in Table II are correct to the nearest half second of arc, and are precisely those that would obtain if these axes were introduced.

The latitudes on the parallel of 24° have been omitted, as the values of $(\phi-\lambda)$ at these stations remain unchanged, whatever axes are employed.

It will be noticed from Table II that the employment of Clarke's axes decreases positive values in Southern India, and negative values in Northern ; consequently the effect of both Himalayan and sub-oceanic attractions is reduced, but the predominance of negative values in the interior of the continent is greatly accentuated.

The employment of the new axes, determined above, is advantageous for the main area in the interior, but largely increases the effect of attraction round the southern coast and in the vicinity of the Himalayas.

Table II.

The values of $(\phi - \lambda)$, *as they would be, if other constants were adopted.*

MERIDIAN OF 72.°			MERIDIAN OF 75.°			MERIDIAN OF 76.°			MERIDIAN OF 78.°			MERIDIAN OF 80°.			PARALLEL OF 18½°.		
AHMEDABAD TO MOOLTAN.			MANGALORE TO KASHMIR.			ÁGAR TO LUDHIÁNA.			THE GREAT ARC—CAPE COMORIN TO DEHRA DÚN.			PONDICHERRY TO SHÁHJAHÁNPUR.			BOMBAY TO VIZAGAPATAM.		
Latitude.	Value of $(\phi - \lambda)$		Latitude.	Value of $(\phi - \lambda)$		Latitude.	Value of $(\phi - \lambda)$		Latitude.	Value of $(\phi - \lambda)$		Latitude.	Value of $(\phi - \lambda)$		Longitude.	Value of $(\phi - \lambda)$	
	With Clarke's Axes.	With new Axes.		With Clarke's Axes.	With new Axes.		With Clarke's Axes.	With new Axes.		With Clarke's Axes.	With new Axes.		With Clarke's Axes.	With new Axes.		With Clarke's Axes.	With new Axes.
									8° 12′	0	+ 7″						
									9° 29′	+ 1″	+ 7″						
									11° 0′	— 1″	+ 5″	11° 45′	+ 4″	+ 10″			
			12° 52′	+ 1″	+ 6″				13° 1′	— 6″	0	13° 4′	+ 6″	+ 11″			
			...	...	...				...	...	...	14° 1′	— 1″	+ 4″			
			14° 8′	— 6″	— 2″				14° 3′	+ 3″	+ 8″	...	...	...			
			14° 17′	— 3″	+ 1″				...	...	...	14° 27′	— 4″	+ 1″	72° 51′	—11″	— 8″
			...	...	...				14° 53′	+ 1″	+ 5″	...	...	...			
			...	...	...				...	...	...	15° 0′	— 4″	0	73° 35′	— 4″	— 1″
			15° 15′	— 2″	+ 2″				15° 6′	— 2″	+ 1″	15° 30′	— 5″	— 1″			
			15° 25′	— 4″	— 1″				...	...	...	15° 56′	— 1″	+ 2″	...	...	...
			16° 25′	— 1″	+ 2″				16° 12′	— 7″	— 4″	16° 26′	— 4″	— 1″	74° 12′	0	+ 3″
			16° 47′	— 2″	+ 1″				...	...	...	17° 1′	— 9″	— 6″	74° 49′	— 9″	— 6″
			...	...	...				17° 8′	— 5″	— 2″	...	...	...	...	...	...
			...	...	...				...	...	...	17° 43′	— 8″	— 5″	75° 41′	— 4″	— 1″
			18° 45′	— 9″	— 6″				18° 3′	— 4″	— 1″	18° 35′	— 1″	+ 2″	75° 46′	—10″	— 7″
			...	...	...				...	...	...	18° 54′	— 5″	— 2″	...	...	...
			19° 30′	— 5″	— 2″				19° 5′	— 6″	— 3″	19° 25′	— 9″	— 6″	...	...	...
			...	...	...				...	...	...	19° 49′	— 7″	— 4″	...	...	...
			20° 44′	— 6″	— 5″				20° 43′	— 8″	— 6″	20° 13′	— 5″	— 3″	76° 19′	— 5″	— 2″
			...	...	...				...	...	...	...	...	...	...	...	...
			22° 1′	+ 1″	+ 2″				21° 6′	— 7″	— 6″	20° 57′	— 7″	— 6″	...	...	...
			22° 47′	— 3″	— 3″				...	...	...	21° 25′	— 7″	— 6″	77° 2′	— 4″	— 1″
			...	...	...				23° 9′	— 5″	— 5″	21° 43′	— 8″	— 7″	...	...	..
23° 7′	— 4″	— 4″	23° 27′	— 5″	— 5″				...	...	...	22° 13′	— 5″	— 5″	...	...	...
24° 6′	—11″	—11″	...	...	...				...	...	...	23° 10′	+ 5″	+ 5″	...	...	...
									...	Kaliánpur.	...	...	...	...	...	Kaliánpur.	
24° 15′	— 8″	— 8″	24° 25′	— 5″	— 5″	...	...	...	24° 56′	...	...	24° 37′	+ 2″	+ 2″	78° 33′	— 7″	— 4″
24° 37′	— 3″	— 3″	...	...	...	24° 25′	0	0	...	0	0	...	...	...	78° 38′	— 6″	— 3″
...	...	...	25° 45′	— 4″	— 5″	25° 38′	— 1″	— 1″	25° 47′	+ 6″	+ 5″	25° 27′	+ 4″	+ 3″	79° 25′	— 8″	— 5″
25° 48′	0	0	26° 18′	+ 2″	— 1″	...	...	...	...	...	...	25° 51′	+ 5″	+ 4″	...	...	...
26° 3′	— 3″	— 4″	26° 54′	+ 1″	0	26° 50′	— 6″	— 7″	26° 57′	— 6″	— 7″	26° 15′	+ 5″	+ 4″	80° 59′	— 3″	0
26° 40′	+ 1″	0	...	...	...	...	...	...	27° 10′	— 5″	— 6″	26° 54′	+ 5″	+ 4″	81° 15′	— 7″	— 4″
27° 17′	+ 3″	+ 2″	27° 55′	+ 1″	— 2″	...	...	...	...	...	...	...	...	...	...	...	...
27° 53′	+ 3″	+ 1″	...	...	...	27° 53′	+ 1″	— 1″	27° 51′	+ 1″	— 1″	27° 21′	+ 1″	— 1″	82° 44′	— 7″	— 4″
28° 30′	+ 4″	+ 1″	28° 30′	0	— 3″	...	...	...	...	...	...	28° 0′	— 5″	— 8″	83° 20′	—10″	— 7″
28° 56′	+ 2″	— 1″	...	...	...	...	...	...	28° 44′	— 5″	— 8″	28° 22′	—10″	—13″	...	...	...
...	...	...	...	...	...	29° 17′	0	— 2″	...	...	...						
29° 22′	— 1″	— 4″	29° 39′	0	— 3″	...	...	...	29° 31′	— 6″	— 9″					South Burma.	
...	...	...	...	...	...	...	...	...	29° 53′	—13″	—16″						
30° 11′	— 1″	— 4″	30° 22′	— 1″	— 5″	...	...	...	30° 20′	—36″	—40″				97° 40′	+ 5″	+ 8″
30° 34′	— 1″	— 5″	...	...	...	30° 38′	— 2″	— 4″	30° 22′	—27″	—31″						
			...	...	...				30° 23′	—45″	—49″				98° 49′	+ 6″	+ 11″
			...	...	...				30° 27′	—34″	—38″						
			31° 18′	+ 3″	0				30° 28′	—31″	—35″						
			31° 38′	+ 6″	+ 3″												
			32° 2′	+ 2″	— 1″												
			33° 55′	—18″	—22″												

Excluding 13 Himalayan stations, the algebraical sum of the values of $(\varphi-\lambda)$ at the remaining 116 stations is as follows :—

	With Everest's first constants.	With Clarke's axes.	With new axes.
If no correction be applied to initial latitude . . .	−185″	−239″	−95″
If the initial latitude at Kaliánpur be corrected by +1″·2	−46″	−96″	+44″

If attraction towards the Ocean on the southern coast be admitted, then the algebraical sum would have a tendency to be positive when the initial latitude had been corrected.

Now omitting the stations on the parallel of 24°, for reasons given above, the following comparisons between the results at northern and southern stations is of interest: the correction of +1″·2 has been applied to the initial latitude first.

Total algebraical sum of values of $(\varphi-\lambda)$	With Everest's first constants.	With Clarke's axes.	With new axes.
At 66 southern stations	−119″	−187″	+18″
At 38 northern stations	+41″	+61″	−1″

From this it is seen how greatly the difference between results at north and south stations is accentuated by the employment of Clarke's axes, and how it entirely disappears with the new axes. The positive value of +18″ for southern stations is what would be expected, owing to the attraction on the coast.

The sums of the squares of the latitude corrections $=[(\phi-\lambda)^2]$ are as follows, omitting 13 Himalayan stations:—

	If no correction be applied to the initial latitude.	If the initial latitude be corrected by +1″·2.
With Everest's first constants	2470	2173
With Clarke's axes	2802	2395
With new axes	2296	2235

In each case there is an improvement shown by correcting the initial latitude at Kaliánpur. This improvement is least in the case of the new axes, and this is because these new axes increase the positive values of $(\phi-\lambda)$ along the southern coast, until they are so comparatively large, that a correction of +1″·2 *greatly* increases their squares.

If the four coast stations, Mangalore, Punnœ, Tiruvendipuram and Madras be omitted, the sum of the squares of the latitude corrections will be :—

	If no correction be applied to the initial latitude.	If the initial latitude be corrected by +1″·2.
With Everest's first constants	2357	2028
With Clarke's axes	2749	2317
With new axes	1990	1857

From this it will be seen how greatly these four coast stations assist the values of Clarke's axes: the rejection of these stations scarcely reduces the sum of the squares at

all, if Clarke's axes are employed, but causes a most marked improvement in the results derived from the new axes.

The Indian Longitudes.

Whilst the Indian latitudes generally show an excess of the astronomic value of an arc over the geodetic, the Indian longitudes show a defect: whilst the latitudes indicate too large a radius of curvature for the meridional ellipse, the longitudes show that the radius of the parallel is too small. These two results are not necessarily antagonistic: a decrease in the value of the ellipticity might make the radius of curvature of the parallel of 24° larger, even if the values of the axes had been decreased.

A comparison of the values of the longitude corrections at stations east of Kaliánpur with the values at stations west, leads to the conclusion that there must be a deflection of the plumb-line in the prime vertical at the initial station of Kaliánpur: this deflection amounts to about 3″, and is towards the west. From the character and comparative paucity of the longitude arcs it is impossible to calculate this deflection with a greater accuracy than to the nearest whole second of arc.

The following are the arcs of longitude measured in India:—

Terminal Stations.	Astronomical value—Geodetic value.			
	If it is assumed that no deflection exists at Kaliánpur.		If a deflection towards the west of 3″ exists at Kaliánpur.	
	Everest's first constants.	Clarke's axes.	Everest's first constants.	Clarke's axes.
Moulmein to Kaliánpur	−18″	− 6″	−15″	− 3″
Prome „ „	−16″	− 6″	−13″	− 3″
Akyab „ „	−12″	− 3″	− 9″	0
Chittagong „ „	−12″	− 4″	− 9″	− 1″
Jalpaiguri „ „	−20″	−13″	−17″	−10″
Calcutta „ „	−11″	− 5″	− 8″	− 2″
Waltair „ „	− 3″	0	0	+ 3″
Fyzabad „ „	0	+ 2″	+ 3″	+ 5″
Madras „ „	− 7″	− 6″	− 4″	− 3″
Jubbulpore „ „	−10″	− 9″	− 7″	− 6″
Bolarum „ „	− 3″	− 3″	0	0
Dehra Dún „ „	−26″	−26″	−23″	−23″
Agra „ „	+ 6″	+ 6″	+ 9″	+ 9″
Kaliánpur to Bangalore	+ 3″	+ 3″	0	0
„ „ Nagarkoil	+ 2″	+ 2″	− 1″	− 1″
„ „ Bellary	+ 1″	+ 1″	− 2″	− 2″
„ „ Amritsar	− 3″	− 1″	− 6″	− 4″
„ „ Mangalore	− 2″	0	− 5″	− 3″
„ „ Bombay	− 7″	− 4″	−10″	− 7″
„ „ Deesa	+ 4″	+ 7″	+ 1″	+ 4″
„ „ Peshawar	−14″	−10″	−17″	−13″
„ „ Mooltan	+ 5″	+ 9″	+ 2″	+ 6″
„ „ Karachi	+ 1″	+ 7″	− 2″	+ 4″
„ „ Quetta	+ 2″	+ 8″	− 1″	+ 5″

Rejecting the three stations situated at the actual foot of the Himalayas, Jalpaiguri, Dehra Dún and Peshawar, there remain, in addition to the initial station, 17 longitude stations in India and 4 in Burma. I have distinguished between the Indian and the

Burmese stations, because the latter, with Everest's first constants, show almost the abnormal differences of the Himalayan stations.

For the arcs of longitude measured over India proper, Everest's first constants are as suitable as Clarke's axes, but the Burmese arcs are immensely in favour of the latter.

The sums of the squares of the longitude corrections are (excluding three Himalayan stations) as follows :—

	4 Burmese arcs.	17 Indian arcs.
With Everest's first constants	868	442
With Clarke's axes	97	465

If we assume that the astronomical zenith at Kaliánpur is displaced 3″ to the east owing to a local disturbance of gravity, the sums of the squares become —

	4 Burmese arcs.	17 Indian arcs.
With Everest's first constants	556	385
With Clarke's axes	19	336

The effect on the constants of the Indian longitudes will be thus seen to depend at present on the inclusion or exclusion of the four Burmese arcs.

Though 55 arcs of longitude have been measured in India, the greater number of these are redundant checks, and there are only 24 independent measurements, whereas there are 129 latitudes. Owing to the system of circuits, the accuracy of a longitude arc is not inferior to that of a latitude. By including local attraction as an accidental and irregular source of error, we get :—

p. e. of a Longitude Arc . . . . = ±2″·79
p. e. of an Astronomical Latitude . . = ±2″·86

Of the 24 longitude arcs, three are abnormally affected by the Himalayas, and a fourth, Quetta, is in the midst of mountains where the deflection of gravity might, from estimation, be anything between +20″ and —20″. Five other longitude stations, Nagarkoil, Bangalore, Bellary, Bolarum and Agra, are situated too near the meridian of Kaliánpur to be of any use in the determination of the earth's axes : they were selected as auxiliary stations in the formation of circuits, and their results afford an additional check on the initial azimuth at Kaliánpur. There are thus only 15 longitude arcs suitable for comparison with geodetic arcs, and of these fifteen more than half have one terminal on the coast. South of the Great Longitudinal Series there are only three arcs without a terminal on the coast, and these three have a north and south direction, and consequently a small amplitude. For these reasons, I think, the Indian latitudes deserve more weight than the Indian longitudes. The apparent antagonism between the two would disappear, if we could reject the four Burmese longitude stations, but their results are above suspicion, and their rejection is out of the question. I think at some future date the introduction of two longitude stations in Upper Burma would afford valuable information, if they were selected carefully.

In the case of the Indian longitudes, the geodetic value generally exceeds the astronomic ; but in the plains of the Punjab and the deserts of Sind, where no mountain ranges exist, the astronomic generally exceeds the geodetic value.

If we omit the Burmese and Himalayan stations and take the four great compound arcs of India, we get the following differences :—

Parallel.	Arc.	Longitude differences.	
		Everest's first constants.	Clarke's axes.
13°	Mangalore-Madras	− 9″·27	— 6″·06
18°	Bombay-Vizagapatam . . .	—10″·07	— 3″·74
24°	Karachi-Calcutta	—10″·59	+ 3″·78
29°	Mooltan-Fyzabad	+ 4″·65	+11″·05

If now we take the sums of the squares of these differences, the result is in favour of Clarke's axes, but as these residuals probably represent, to a large degree, the effect of

sub-oceanic attraction, they cannot be regarded as irregular or accidental discrepancies, and the sums of their squares are unreliable tests.

I was induced this summer to undertake this examination of the results of the Indian latitudes, by my repeated failures to predict even the direction of a deflection of the plumb-line. As the calculations entailed considerable extra work, I have included my results in this report. Though these results are disappointing and inconclusive, and though I have been only able to approach the subject from the point of view of an observer, I think the discussion may perhaps be of some assistance, when latitude operations are resumed, and when new latitude stations have to be selected.

Extract from the Narrative Report of LIEUTENANT G. P. LENOX-CONYNGHAM, R.E., *in charge No. 23 Party (Astronomical), Season 1893-94.*

During the preceding season (1892-93), latitudes had been determined at each of the azimuth stations of the Bombay Longitudinal Series, and with a view to the work being continued over the Bider Longitudinal Series the equipment and instruments were stored at Secunderabad.

The programme of work comprised the determination of the latitudes of the following seven stations:—

		Latitude.	Longitude.
		° ′	° ′
(1) Bolarum	(longitude station)	17-30	78-34
(2) Pirmulo H. S.	(azimuth station)	17-53	78-38
(3) Vanakonda H. S.	„	17-36	79-25
(4) Singawaram H. S.	„	17-45	80-59
(5) Parampudi H. S.	„	17-13	81-15
(6) Sanjib H. S.	„	17-31	82-44
(7) Waltair	(longitude station)	17-43	83-20

I left Dehra on 14th November 1893 for Bolarum, where a pillar had already been prepared for me on the site of the longitude station used in 1891-92; Colonel Fox, R. E., in the compound of whose office it is situated, having kindly allowed me to have the necessary work done.

When I set up my instrument I found that in some unexplained way the liquid in the level (No. 4, by Holmes), which is mounted on the zenith telescope and on which the work depends, had evaporated or leaked, so as to leave a bubble of inordinate length at a temperature of 68°F.—the length of the bubble was 138 divisions,—and as the total length of the scale is only 170 divisions, it would have been impossible to carry on the work with the level in this state. I telegraphed therefore to Dehra for another and received an answer to the effect that the only remaining level of this class had developed the same fault as mine, but that Captain Burrard, in charge of No. 22 Party, had been asked to send me one of his if he could spare one. As No. 22 Party had left Bikanir and was in the desert before the request arrived, it took some time to send the level back to the railway, and not till the 15th December did it reach me. During this long wait I employed myself in re-determining the value of my micrometer screw and seeing to the various instrumental adjustments. As soon as the level arrived I determined its value and then set to work on the latitude observations. I was again delayed a few days waiting for the Peshkar, whom His Highness the Nizam's Minister had promised to send to accompany the party, and finally started for my second station, Pirmulo, on 28th December.

The Great Trigonometrical Survey station of this name is situated on an immense boulder at the top of a low rocky hill. This boulder was not large enough for the observatory tent, and the pillar was therefore built in a suitable place in the prime vertical to the East. The work was slightly interrupted by cloudy weather, but I obtained 48 double observations. The next station was Vanakonda H. S. This is a high and conspicuous hill covered with jungle. There were still traces of the road formerly made by the triangulation party, but the instrument being very light a shorter and steeper route was selected and cleared. The hill apparently has a bad reputation, partly superstitious and partly owing to the belief that it is inhabited by wild beasts; an old man, the patel of a neighbouring village, declared that since the triangulation party had been there in 1869 no one had ever been up it. I obtained 46 double observations.

Between this and my next station, Singawaram, the Bider Longitudinal Series is cut by the Jubbulpore Meridional Series, and a latitude had been observed at Bolikonda H. S. common to both series, in 1888-89. I had therefore a double march to do. I had been rather undecided as to whether I should make for Parampudi and thence go up the Godávari to Singawaram, or go to the latter *viâ* Yellandu and thence down the Godávari; it was evident that the latter would be the better route so long as there was a road of any sort from Yellandu onwards. I ascertained that there was a fairly good track, and also that there was a good metalled road from the Godávari to a point not far from Parampudi.

The march from Vanakonda to Yellandu was a long and difficult one. In the summer of 1893 there had been exceptionally heavy rains, which had caused many of the numerous tanks to overflow, and induced the inhabitants to cultivate rice in larger quantities

than usual. The result was that the ordinary tracks had very frequently to be abandoned and a way found by some circuitous route. We struck the Godávari at a point opposite Bhadrachélam, where arrangements had been made for boats to take the party across and for fresh carts for the remaining march to Singawaram.

Singawaram H. S. is situated at the top of a conspicuous hill, about 3 miles to the east of the Godávari. It is very thickly covered with jungle and on all sides, as far as the eye can reach, there is nothing but thick jungle, except here and there where small clearings have been made near villages. At this station I lost one night through cloudy weather but obtained 44 double observations.

I noticed a peculiarity at this station which I was unable to account for, namely, that at night it was very much cooler in my camp at the foot of the hill than in the observatory at the top. The difference in level was about 400 feet, and I should think that at midnight it was 10° cooler at the foot of the hill.

On finishing my observations I marched back to Bhadrachélam and thence took boat down the Godávari. We disembarked at a place called Prakkaylanka, whence an excellent metalled road took us to a point within 12 miles of Parampudi station. The station is situated on a low jungle covered hill, near a very small village of the same name. The observations were completed here in 5 days.

From Parampudi we retraced our steps to the Godávari and took to boats again for one day. This brought us to Rajahmundry, whence we went by rail to Waltair. The longitude station at Waltair is situated in the compound of a house belonging to the widow of the late Nursing Rao. At this station I observed three programmes twice each, obtaining 52 double observations.

The remaining station, Sanjib H. S., was reached by taking the train to Narsipatam road station and thence making one march to the foot of the hill. The hill is over 2,000 feet high and very steep. The summit is very rocky and all the water had to be carried up from the foot. There were a good many clouds, but by being constantly ready to take advantage of a temporary clearing up I succeeded in finishing in four days. This closed the season's work, and the party returned to Secunderabad.

There is very little to say of the work from a professional point of view. The instrument worked satisfactorily throughout, except in the matter of the level previously referred to. The levels used with the zenith telescope belong to a set of six made by Holmes, and are, so far as I am aware, the only ones with reservoirs which have been in use in the department. I have received through the officer in charge of the Mathematical Instrument Office a letter from Mr. Holmes, in which he explains that the liquid used in the levels made by him is chloroform, and that chloroform is liable in the course of time to a chemical change, causing it to contract in bulk, so that the diminution of the amount of liquid in the levels is not due either to evaporation or leakage. Mr. Holmes adds that to abandon the chloroform in favour of spirits would greatly diminish the sensitiveness and accuracy of the levels,—a statement well borne out by the great superiority, particularly in rapidity of settling, of his levels over any others that I have used,—and concludes by saying that all that can be done is to have the levels refilled annually.

If, however, as now seems clear, the reservoirs in these levels are not to blame, there is no reason why they should not be made considerably larger so as to hold a sufficient quantity of chloroform to replace all the loss that would occur in a considerable number of years, and so prolong the life of the level to any reasonable extent.

In the computations, the value of the micrometer screw deduced from the work of season 1890-91 was employed, but a scrutiny of the Table II below, in which the results are classified according to whether the sign of the micrometer correction was positive or negative, clearly shows that this value is too small. The mean of the errors therein deduced is 0″·0101, and the value of one revolution must be increased by that amount. As the weights of the means of results with positive and with negative micrometer corrections respectively, are in each case approximately equal, it is not necessary to correct each individual result. A sufficiently close approximation has been obtained by correcting the mean of the above means by a quantity depending on whether the mean positive or mean negative correction was in excess. This is done in Table III, and Table IV contains final latitudes, also the geodetic values, and the difference between the two.

That the value of the micrometer screw should have altered appears at first sight very unlikely, but when it is recollected that the "value" means the angle subtended at the object glass by the space between two threads, it is evident that it will alter with every re-adjustment of the focus, and as determinations by observations of a polar star at elongation, at least when made without the assistance of an electric chronograph, do not give the result with a probable error less than the correction now deduced, it appears that this method of deducing the value from the season's observation, and then correcting the latitudes is the best that can be devised. In future it will be better to do this before taking out the probable errors, as those now given must be considerably larger than the true ones. The old value of one revolution of the micrometer screw was 69″·345, and the correction now determined is 0″·01. The focal length of the telescope is about 3 feet, so that to find the linear movement of the eye end necessary to produce this change in value we have—

$$\frac{69''\cdot345}{0\cdot01}=\frac{3\text{ ft.}}{x}.$$

whence $x=0\cdot00519$ inches, or about $\frac{1}{200}$ of an inch.

In a brass tube 3 feet long an increase of temperature of about 13° Fahrenheit would produce a linear expansion of $\frac{1}{200}$ of an inch, it is clear, therefore, that even if the focal adjustment were never touched, such an error in the value of the micrometer, as has been found this year, could easily occur.

It is obvious that small probable errors cannot be expected unless the actual value of the micrometer revolution at each station is very accurately known, but this does not imply that the final value of the latitude will be untrustworthy, for so long as the mean positive and mean negative correction are equal, and the number of results with positive is the same as the number with negative correction, no error, however large, in the adopted value of the micrometer revolution, would affect the result. To ensure that these conditions are exactly fulfilled would be impossible, but a sufficient approach to them is always obtained, as a scrutiny of columns 5 and 6 of Table III will show.

The four tables which are appended sufficiently explain themselves.

Table I.

Preliminary values and probable errors.

Station.	No. of pairs.	Astronomical Latitude. Φ	Probable Error.
Bolarum	47	17° 30′ 7″·46	±0″·060
Pirmulo	48	17 52 58·45	±0 ·069
Vanakonda	46	17 36 0·24	±0 ·057
Singawaram	44	17 45 8·70	±0 ·070
Parampudi	43	17 12 32·65	±0 ·064
Waltair	52	17 43 20·44	±0 ·053
Sanjib	41	17 31 12·41	±0 ·068

Table II.

Deduction of error of adopted value of 1 revolution of micrometer, from comparison of results with positive and negative corrections.

Station.	Mean value with positive micrometer correction.	Mean value with negative micrometer, correction.	Difference.	Mean positive micrometercorrection.	Mean negative micrometercorrection	Sum.	Apparent error in adopted value of 1 revolution.
	″	″	″	″	″	″	″
Bolarum	52·36	52 67	—0·31	17·1	21·7	38·8	—0·0080
Pirmulo	1·34	1·70	—0·36	31·5	30·6	62·1	—0·0058
Vanakonda	59 50	0·01	—0·51	16·1	27·7	43·8	—0·0117
Singawaram	51·09	51·51	—0·42	21·7	19·6	41·3	—0·0104
Parampudi	27·03	27·66	—0·63	28·1	22·7	50·8	—0·0124
Waltair	39·38	39·87	—0·49	24·7	26·1	50·7	—0 0096
Sanjib	47·26	47·96	—0·70	33·4	20·4	53 4	—0·0130

Mean of apparent errors —0″·0101,
i.e., adopted value of one revolution is too small by 0″·0101.

Table III.

Application of the correction found in Table II to preliminay values of co-latitude.

Stations.	Mean co-latitude with positive correction =a.	Mean co-latitude with negative correction = b.	$\frac{a+b}{2}$	Mean positive correction = m.	Mean negative correction = n.	$\frac{m-n}{2}$	$\frac{m-n}{2}\times\cdot01$ =c.	True co-latitude $=\frac{a+b}{2}+c.$
	″	″	″	″	″	″	″	″
Bolarum	52·36	52·67	52·52	17·1	21·7	—2·3	—0·02	52·50
Pirmulo	1·34	1 70	1·52	31·5	30 6	+0·5	+0·00	1·52
Vanakonda	59·50	60·01	59·76	16·1	27·7	—5·8	—0·06	59·70
Singawaram	51·09	51·51	51·30	21·7	19·6	+1·1	+0·01	51·31
Parampudi	27·03	27·66	27·35	28·1	22·7	+2·7	+0·03	27·38
Waltair	39·38	39·87	39 63	24·6	26·1	—0·8	—0·01	39·62
Sanjib	47·26	47·96	47·61	33·4	20·4	+6·5	+0·07	47·68

Table IV.

Final Latitudes and differences between Geodetic and Astronomical values.

Stations.	Astronomical Latitude. ϕ	Geodetic Latitude. λ	$\phi - \lambda$
	° ′ ″	° ′ ″	″
Bolarum	17 30 7·50	17 30 13·41	−5·91
Pirmulo	17 52 58·48	17 53 2·95	−4·47
Vanakonda	17 36 0·30	17 36 6·87	−6·57
Singawaram	17 45 8·69	17 45 10·38	−1·69
Parampudi	17 12 32·62	17 12 38·28	−5·66
Waltair	17 43 20·38	17 43 29·31	−8·93
Sanjib	17 31 12·32	17 31 18·68	−6·36

TIDAL AND LEVELLING OPERATIONS.

Extract from the Narrative Report of Lieutenant-Colonel J. Hill, R.E., *in charge No. 25 Party—Season 1893-94.*

During the field season I inspected the tidal observatories at the western stations (excepting Bhávnagar and Aden), namely, those at Maskat, Bushire, Karachi, Apollo Bandar (Bombay), and Prince's Dock (Bombay), in the order named. I did not think it necessary to go to Bhávnagar, because the works at Port Albert Victor had not made sufficient progress to require inspection by me, and the requisite series of tidal registrations at the Bhávnagar tidal observatory ended while I was engaged on inspection duty elsewhere. I, therefore, arranged to send an assistant to Bhávnagar to take zero measurements, etc., dismantle and clean the instruments, which are the property of the Bhávnagar State, hand them over to the State Engineer, and close the observatory. As regards Aden, it was not convenient to make an inspection of the observatory there before the close of the year under report, owing to circumstances which I shall now mention ; but I have arranged to have the inspection made early in the ensuing year. The field season was signalised unfortunately by a disaster which altered several of my plans. On the afternoon of the 25th December 1893, when I arrived in Karachi by steamer from Bushire, I received telegrams informing me of the wreck, in a heavy storm, of the Bushire tidal observatory. This necessitated consultations while I was at Karachi with Mr. D. Morris, the Port Engineer, who most kindly volunteered his assistance, and the preparations of plans, etc., at Poona afterwards. During my stay at Karachi, in addition to inspecting the tidal observatory, I took the opportunity to find out the condition of the bench-marks laid down in the course of our spirit-levelling operations in Karachi and its neighbourhood, executed in 1859-60 and 1883. The bench-mark of reference of the tidal observatory (laid down in 1880 and transferred to another stone of exactly equal height in 1883) had of course been carefully preserved, being, in common with the observatory, inspected every year; but all the other bench-marks had disappeared, with the exception of a bench-mark cut at the main entrance to Holy Trinity Church, Karachi, which bench-mark has become useless, owing to its having been sinking gradually for some years. I had, therefore, to arrange for laying down and connecting a new series of bench-marks, extending from the tidal observatoy at Manora through Kimari and Karachi and thence by the Tatta road and Thul railway station to the south end tower of the Karachi base-line of verification ; together with the publication of the heights of the bench-marks in a special pamphlet. I mentioned in my last annual report that, before going on privilege leave, I instructed Lieutenant Morice to obtain, from Port Officers and other qualified persons, by means of circulars, certain information required for the preparation of an Indian Co-tidal chart. The information so obtained, together with that obtained from the Marine Survey, our own observations and other sources, has been utilized, and will, I hope, enable the chart, which is already well advanced, to be submitted for publication, at the time I mentioned, before the spring, namely, of 1895. The chart is constructed on Mercator's projection so as to be useful to naval men, and it shows the tidal and levelling operations of the department, as well as the co-tidal lines.

The work carried on during the year will now be noticed in detail.

Tidal Operations.

During the survey year under review, tidal observations by means of self-registering gauges, were taken at thirteen stations, namely, *Aden*, Maskat, Bushire, *Karachi*, Bhávnagar, *Apollo Bandar* (*Bombay*), Prince's Dock (Bombay), Minicoy, Trincomalee, *Kidderpore*, *Rangoon*, Mergui, and *Port Blair*. The seven tidal stations, whose names are not italicised, are minor stations, where observations, as a rule, are taken for five years only. Prince's Dock is included among them, as the continuance of its registrations beyond the limit of five years is not required by the general scheme of tidal operations,

although the registrations are so useful to the officials of the Docks that they seem likely to be continued indefinitely. The six stations, whose names are italicised, are permanent stations, where the minimum period of observations lasts for 19 years, and where observations should continue to be taken until the work at all the stations is completed. In addition to the observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily, with the object of comparing the actual heights and times of High and Low Water with those predicted in the tide-tables at the following tidal stations, at all of which the tidal observatories are closed :—Cochin, Tuticorin, Colombo, Chittagong, Akyab, Moulmein.

The tidal observations at Mergui and Bhávnagar were closed on the 6th June and 17th August 1894, respectively, five years' observations having been completed at these stations.

The tidal observatory at Bushire was wrecked, in a storm, on the 19th December 1893 : it was re-erected on an iron substructure, and the observations were resumed on the 23rd April 1894. No new tidal observatories were established during the year.

It will be seen from the foregoing, combined with the particulars given in previous Annual Reports, that since the resumption of tidal operations systematically in 1877, observations have been taken at 33 tidal observatories, of which 22 (including Madras) have been closed on the completion of their registrations, and 11 are now in operation.

During the year 1894-95 tidal observations will be continued at the following stations where they are now being taken, *viz.*, Aden, Maskat, Bushire, Karachi, Apollo Bandar and Prince's Dock (Bombay), Minicoy, Trincomalee, Kidderpore, Rangoon, and Port Blair. No observatory will be closed. Two new tidal observatories will be opened, those, namely, at Madras and Diamond Island, and possibly the proposed tidal observatory at Port Albert Victor in Káthiáwár; but the completion of the last-named observatory within a year from the present time does not seem probable.

Regarding the proposed resumption of tidal observations at Madras, I hoped it would not be necessary to report any further delay about it beyond that which I mentioned in my last Annual Report, but I regret to state that the tidal observatory is not yet ready, and that I must continue the story of delay where I left it off last year. I mentioned then that in compliance with the request of the Engineer, Harbour Trust Board, I sent him drawings on the 30th March 1893 to enable him to put up a sanctioned temporary observatory in which to take tidal observations, pending the completion of the permanent observatory on the northern arm of the harbour. In the following November, having heard nothing further on the subject, I directed Mr. Belcham, who had to pass through Madras, to see the Engineer and find out what had been done. He reported that the Engineer informed him that the Harbour Trust Board had not thought it worth the expense to erect a temporary building, when the arms of the harbour were so near completion; but I may here remark that they sanctioned the erection of a temporary building in their Resolution No. 7 of the 20th January 1893, on the express recommendation of their Engineer; and that they sent me no intimation that they had rescinded their resolution. Mr. Belcham's report, thus far, was not very encouraging; but it proceeded to inform me that the Engineer expressed the hope that the permanent tidal observatory would be ready in May 1894. That hope, however, was not destined to be realised, and after waiting until August 1894 without receiving any communication whatever from the Engineer, I was obliged to write to the Secretary, Harbour Trust Board, a letter which ended as follows: "It is now sixteen months since I sent your Engineer the plans he asked for, and it is to me a matter of regret that so many months' tidal observations have been lost. I, therefore, venture to express the hope that the Board will now inform me when they expect the permanent tidal observatory will be ready for the reception of the tidal apparatus." In reply he stated that it was hoped that the observatory would be ready very shortly. That was not very definite; but a few days afterwards he wrote saying that "the Engineer reports that the chamber for the tidal observatory will be ready to receive the instruments by the end of September." On receipt of this information I wrote to the Engineer asking for a rough sketch of the chamber, etc., to enable me to complete my preparations, and mentioning certain precautions necessary in the details of the design. In his reply he expressed the hope that the observatory would be ready either by the end of September or early in October. The Secretary to the Harbour Trust Board also wrote to me, on the 26th September, saying that the Engineer informed him that he hoped to have the tide-gauge chamber ready early in October. Much hope has thus been expressed, and there the matter now stands.

With reference to the establishment of a tidal observatory on Diamond Island, at the mouth of the Bassein River in Burma, I stated in my last annual report that the observatory was ready, and that one of Mr. Belcham's first duties would be to proceed to Diamond island to set up the apparatus and start the tidal observation. My report was written in October 1893, and on the 22nd of the following month the Executive Engineer, Bassein Division, wrote enquiring when I would arrange to put up the apparatus, and asking me to bear in mind that the best season is the end of December and all January and February. I had written to him, on the 16th of the same month, that I had instructed Mr. Belcham to start the observations in December, and our letters crossed in transit. Subsequently he telegraphed and wrote asking me to defer sending Mr. Belcham, as it was found that the observatory had been damaged during the monsoon. I was unable to comply with this request, for Mr. Belcham was then at Port Blair, from which place I had

ordered him to proceed to Calcutta, and thence to Burma, to inspect the work done at Diamond Island, and, if possible, start the observations, then to inspect the Rangoon tidal observatory, and afterwards to proceed to Ceylon, and it was impossible to alter this programme, on which his work for the whole field season depended. Also, as I had been ready to undertake the tidal observations at Diamond Island for the past three years, I naturally did not wish to lose the opportunity of obtaining Mr. Belcham's report on the actual state of the work there. He visited Diamond Island from the 25th to 29th December 1893, and finding the communication with the sea quite closed, and being unable to open it, he, in accordance with his instructions, continued his tour of inspection. On the 15th February 1894, the Executive Engineer again telegraphed to me saying that the observatory was ready, and that a man should be placed in charge of it. Before the receipt of this telegram, Mr. Belcham and his tidal observatory inspection party had left Poona to re-erect the tidal observatory at Bushire, which, as already stated, had been wrecked in a heavy storm, and the other tidal observatory inspection party was at the island of Minicoy. I, therefore, replied to the Executive Engineer, that my two inspection parties being engaged on work which could not be interrupted, I was not then in a position to start the work at Diamond Island; but that the telegraph master at that place, who had to undertake the duties of tidal observatory clerk, ought to be placed in charge of the observatory at once in order that he might keep the communication open until I should be in a position to put up the tidal apparatus. I also pointed out the advantage of having a series of experimental comparisons of the water-level within and outside the float-cylinder by means of graduated poles taken, so that there might be no doubt regarding the working of the communication pipes and cylinders before commencing observations with a self-registering tide-gauge. I gave him all the necessary details, and in a subsequent letter, written to him during the same month, I said I thought it "as well to state clearly that, in view of the past history of the operations at Diamond Island, I do not feel justified in incurring the expense of sending my tidal assistant and his men, together with the self-registering tidal apparatus, to Diamond Island, until I have evidence from a sufficient number of experimental comparisons, between the water level within and outside the float-cylinder, that the communication may be considered to be generally free and not liable to interruption." The telegraph master took the necessary experimental observations during the past rainy season, sending them to me week by week, and I am glad to report that they are very satisfactory, and show that communication has been quite free throughout the season. The self-registering tide-gauge observations will accordingly be commenced at the earliest possible date during the approaching cold season. During the rainy season it would not have been possible to put up the apparatus. In my annual report for 1891-92, I commented on the difficulty of communicating with Diamond Island during the rainy season, the objections to that locality as a tidal station, and the great labour and heavy expense that have been incurred to obtain tidal observations there. I need not now do more than refer to the opinions I then expressed, which subsequent events have abundantly confirmed.

My cordial thanks are due to Mr. D. Morris, the Port Engineer at Karachi, for his invaluable help in constructing the iron substructure for the Bushire tidal observatory, and for all the other assistance he afforded us in re-establishing the observatory there. Details of this work will be found further on. I wish also once more to mention my obligations to Commander A. Channer, R. N., for his kindness in carrying our men and their supplies between the Island of Minicoy and Ceylon, thereby much facilitating our operations.

I shall now describe briefly the working of each tidal observatory, commencing with Aden and following the order of the stations round the coasts to Burma; including in this survey those stations where in lieu of automatic tidal observations, personal observations to a graduated staff are taken daily, in order to furnish comparisons between the actual and the predicted heights and times of high and low water.

Aden.—The observations at this station have been satisfactory on the whole, the self-registering tide-gauge having worked well throughout the year, except in the following instances: The spring regulator clock stopped on the 2nd January 1894; after ineffectual efforts to re-start it, the spare pendulum clock, kept in the observatory and mentioned in my last annual report, was substituted for it on the 5th; this clock stopped on the 7th, and on the 8th the spring regulator clock, which had been thoroughly repaired, was re-attached to the gauge. From this time until the 13th of the same month the clock had a large error; but it was then regulated, and has been working well up to the present. From the 13th June to the 8th July about low water the pencil marked a straight transverse line on the diagrams a little above the 4-foot line, except on the 26th and 27th June when the tide did not fall so low, and on the 21st when the pencil appears to have overcome the obstacle, which probably consisted of grit or dirt allowed by the clerk to settle on the guiding parallel bars. The clerk professed his inability to discover the cause of the obstruction to the motion of the pencil. As regards the manner in which his work was performed throughout the year, he was on leave from the 1st January to the 2nd April, and during this time his work was not done properly by the man appointed locally to act for him. Under present arrangements the clerk is obliged to work both in the Port Office and in the tidal observatory; and the amount of work required from him, which includes a walk to the top of Flag Staff hill every day, is more than an ordinary man can be expected to do properly in a climate like that of Aden. I recommend that so long as he is required to do this double duty he should be provided with an assistant.

The auxiliary instruments have worked without a single failure throughout the year.

The tidal observatory was not inspected during the year, for the reason already mentioned.

Maskat.—At this station the self-registering tide-gauge has behaved remarkably well. There was only one short break of 10 hours in the registrations during the year, owing to the unavoidable stoppage of the clock, which ran down on the 21st November. During the cyclonic weather, from the 18th to the 21st November 1893, all attempts to get to the tidal observatory were ineffectual, owing to the dangerous roughness of the sea, and the clerk was then unable to wind the clock before it ran down. During the cyclone, the observatory, owing to its sheltered position, remained quite safe ; but half of the stones were washed out of the north dam (described in last year's Annual Report) which closes the indentation in which the tide-gauge works, converting it into a protected well or cistern, the framè-work of which dam consists of a double row of massive beams and rails ; and all the loose stones forming the small rough stone wall to the south of the observatory were washed into the well and, together with debris from the north dam, were heaped round the cylinder, without, however, doing it any damage. By the 1st December the dam was repaired and the debris around the cylinder removed. On the 7th and 8th January 1894, the weather was again so bad that the clerk could not visit the observatory, but neither on this, nor on any subsequent occasion, did the clock run down. Bad weather was again experienced from the 10th to the 12th February, when the north dam was again somewhat damaged. It was repaired by the 20th of the same month, and since then no further damage has been reported, although there was bad weather again in June.

Of the auxiliary instruments, the aneroid barometer has worked without interruption, and has shown diurnal variation ; but it is not sufficiently sensitive, and has required tapping to bring it into agreement with the standard mercurial barometer.

The clock of the anemometer got out of order on the 9th July and had to be sent for repair to Poona. It was set going again on the 17th August, and the registrations of the instrument have been very satisfactory. The rain gauge remained in good order. The standard sundial has answered its purpose well. The clerk has taken observations with it regularly week by week since the operations commenced in order to check the error of the chronometer. The rate of the latter has been found very regular (about 18 seconds daily, losing), and the tide-gauge clock has been kept to correct time.

I inspected the tidal observatory, on the 9th December, and found and left everything in a satisfactory condition. I had sent Surveyor Dhondu Vinayek in advance to do the necessary cleaning and adjusting of the instruments, and to take the usual measurements. He arrived on the 25th November, having experienced at sea the cyclonic weather already mentioned, and found the tidal observatory building and anemometer house in good order. On seeing what had occurred, between the 18th and 21st November, he set coolies to work, who cleared the well and filled the north dam with stones, adding some new posts and planks, the better to retain the stones. The rough stone wall to the south of the observatory, having proved disadvantageous, was not rebuilt. The cylinder was freed from rust ; the wood-work tarred where necessary ; and everything restored to good condition. It was noticed that between 2 and 6 P. M. daily the drum of the tide-gauge did not keep strictly in time with the driving clock, losing about two minutes in the hour. The tide-gauge (as mentioned in last year's annual report) is the instrument that was previously in use at Cocanada ; and at my inspection of that tidal station, in February 1888, I noticed this defect in the instrument, remedying it by changing the cord of the back-lash weight from its place on the axle to the surface of the drum. The same plan was again adopted, and the time recorded on the drum has since agreed with that indicated by the clock. A small hole was also cut through the observatory floor and fitted with a vertical case open at the top, and going down below the level of the floor, for the pencil-counterpoise weight to work in, and so allow the pencil to move along the entire length of the drum, without the necessity of using a secondary pulley which originally carried the weight, and under which the cord passed from above, to rise again as far as the bed-plate where its end was secured. This pulley had been removed by the clerk, under the impression that some irregularities in the tidal curves had been due to its action. The graduated staff was removed, cleaned, painted, and refixed in position ; and its zero tested and found to agree with that of the tide-gauge.

Meteorological records have been forwarded periodically by the clerk to the Meteorological Reporter to the Government of India, whose meteorological instruments, as well as all the other instruments, have been kept clean by the clerk, and attended to punctually according to instructions.

The clerk and his assistant clerk are both careful and trustworthy men, and have performed their duties very satisfactorily.

Major J. Hayes Sadler, Her Britannic Majesty's Consul and Political Agent at Maskat, has the kindness to visit the observatory occasionally ; and my thanks are due to him for his continued co-operation, and the interest he takes in the operations.

Bushire.—At this station the self-registering tide-gauge worked most satisfactorily and without a single stoppage, until the 19th December 1893 when, between 4 and 5 P.M., during the final burst of a long continued and heavy gale from the south-east, the foundation of the tidal observatory gave way, and all the masonry above the well was destroyed, except the north-east corner. The wooden observatory house, which had rested on the masonry substructure, was fortunately only tilted over and, with all the apparatus

contained within it, was saved; but the tide-gauge although saved was much damaged, and the tidal observations had to be suspended until the 23rd April 1894, when the observatory, after being re-erected, was re-opened for observations. I was informed that so heavy a gale had not been known at Bushire for ten years; nevertheless the masonry substructure would have weathered it if it had been built with good mortar; but the debris showed no signs of mortar; in spite of a facing of Portland cement, it had all been washed out, and the stones fell separately and did not come down in blocks; the wonder being that the structure had successfully resisted occasional severe weather for more than a year, and that it withstood during the 17th and 18th December the storm that eventually wrecked it. Mr. Morris, the Port Engineer of Karachi, to whom I showed a sketch of the original observatory, agreed with me that it was strong enough as designed. Its erection is described in my Annual Reports of 1891-92, and last year (1892-93):

"I inspected the observatory from the 16th to the 18th December 1893 and found that, in spite of the heavy weather, everything, to all outward appearance, was safe and sound, and the tide-gauge working very satisfactorily. I, therefore, decided not to stay for an extra week at Bushire, but to leave by the mail steamer, advertised to sail on the 19th, and go to Karachi, where I had preliminary work to do connected with the spirit levelling there, leaving Surveyor Dhondu Vinayek to finish off the measurements and other details of the Bushire inspection. On the afternoon of the 19th, I reached the mail steamer, which was anchored out some miles from shore, in the pilot boat, the only craft in Bushire that would venture out to sea. After being almost swamped, and, in spite of water-proofs, altogether drenched, I got on board at about 4 o'clock. The weather was so bad that the steamer was unable to start until the following morning, and, owing to its being impossible to transmit messages from shore, I was unaware of what had happened to the tidal observatory, until on arriving at Karachi I received telegrams on the subject from Bushire. I then applied personally to Mr. Morris, the Port Engineer, who most kindly interested himself in the matter, and arranged with him for the construction at his workshops of an octagonal iron substructure, the corner posts of which were to be embedded 3 feet in the solid rock, to surround the well and support the timber cabin of the Bushire tidal observatory. It was decided that the substructure should be formed of old rails, and that an annulus of stone laid throughout in Portland cement should be built round the top of the well, enclosing within its mass the lower part of the iron substructure. After finishing my business in Karachi and returning to Poona, I sent Mr. Morris from the latter place, on the 16th January 1894, the necessary drawings for executing the work, namely, a plan and sectional elevation, a working plan and an erecting plan, and he put the work in hand at once. The drawing of these plans was the work of Lieutenant Morice. I also telegraphed, on the same day, to Mr. Belcham, recalling him to Poona as soon as his work at Trincomalee should be finished. At Poona, Mr. Belcham was employed for a few days preparatory to going to Bushire, in the manner described previously. He arrived in Karachi on the 17th February, and, in addition to other work, he assisted in the completion of the iron substructure and set it up experimentally before taking it to Bushire. He left Karachi on the 6th and reached Bushire on the 16th March. Some time was occupied in cleaning the well and removing the debris; but, by the 21st April, the communication pipe, 47 feet long, had been taken up, cleaned and relaid; the annulus built; the substructure put up and the cabin erected upon it; the float cylinder placed in position; a new rain-gauge pillar, built on the top of the Telegraph Office, to replace the original one which had stood there until the 19th December, when it was carried away by the storm; and bench-mark A. from which the inscribed stone had been purloined, restored to its original condition. On the 22nd April, a new tide-gauge brought from Poona, and adjusted to work on $\frac{1}{3}$ the natural scale, instead of on the $\frac{1}{2}$ scale as formerly, was set up and experimental observations taken with it, and after its bed-plate had been connected by levelling with the bench-marks of reference, and its zero adjusted to the original value, the regular registrations were resumed on the 23rd April. From this date until the 5th May Mr. Belcham remained at Bushire, employed in superintending the putting of the finishing touches to the observatory, in watching the performances of the tide-gauge and other instruments, in taking zero measurements, and in instructing Mr. J. O. Twells, one of the senior telegraph clerks, who was placed in charge of the observatory from the date of its re-establishment, in the duties of tidal observatory clerk. Mr. Belcham left the observatory and all the instruments in thoroughly good order, and reported that Mr. Twells understands his duties in every particular. A careful and detailed description, with plan and sectional elevation, of the new observatory, prepared by Mr. Belcham, is filed in my office, together with photographs of the observatory as it now stands. I am greatly indebted to Mr. T. Y. Johnstone, Superintendent of Telegraphs, and his assistant, Mr. R. C. Campbell, for their prompt action, at the time of the accident, in saving the instruments and making secure the observatory cabin, in co-operation with Surveyor Dhondu Vinayek, as well as for their help, most freely accorded in many ways to Mr. Belcham while he was engaged in re-erecting the observatory. Mr. Johnstone continues to exercise a general supervision over the observations. I have already mentioned above my obligations to Mr. D. Morris generally; but I would add here that, in addition to constructing the iron substructure in his workshops, he lent Mr. Belcham a quantity of tools, etc., without which the erection of the substructure would have been very difficult, and also provided him with a mason and a mechanic, who accompanied him to Bushire and both of whom assisted him most efficiently. Mr. Morris also did not charge

the customary commission on the work done; but only the bare cost-price of the materials, and the actual cost of labour.

The tide-gauge now working at Bushire is tide-gauge No. 22, which was last used at Tuticorin. It is one of the new pattern by Adie, with chain attachment to the pencil traveller; but the regulator clock of the damaged tide-gauge was attached to it at Bushire by Mr. Belcham, in lieu of its own pendulum clock, and the latter was brought back by him to Poona. The readings of the gauge are checked daily by a comparison of the water-level inside the float-cylinder, as indicated by the pencil on the drum, with that outside as indicated by a graduated staff fixed near the outer end of the communication pipe. Since the tide-gauge was set up, on the 23rd April, it has worked very satisfactorily, the interruptions to its registrations having been few and unimportant. The pencil failed to mark for a short time on the 7th and 28th May, and on the 21st and 22nd July; and on the 11th June there was a short interruption of two hours and a half, due to the breaking of the cord of the back-lash weight, and a further interruption the same day, owing to the cord after being repaired having been wound in the wrong direction round the axle; by the time this mistake was rectified it had caused an interruption to the registrations of about five hours.

The record of the aneroid is fairly good The clock stopped only once, namely, on the 26th April, while Mr. Belcham was at Bushire; but for some time previously it had been losing several minutes per diem, and had to be set daily by the clerk. Mr. Belcham also found a material difference between the readings of the dial and of the pencil. Also, there was no record for the fortnight between the 23rd October and the 6th November, owing to the supply of diagrams having run out, the periodical return of stores required not having been submitted in time.

The anemometer has worked well. At my inspection it was found that, while the velocity gear was in good adjustment, the direction gear did not record accurately, owing to the connecting pin having fallen out. Subsequently, during the 10th February, no record was obtained, owing to the spirals not having been let down upon the diagram.

Karachi.—At this station the self-registering tide-gauge worked very satisfactorily throughout the year. The only irregularities were the following:—

The communication became imperfect on two occasions, for three hours and one hour, respectively; the float-band stuck on the stud-wheel once, for a short time; and there were five short stoppages of the clock. The gaps in the tidal curves, so occasioned were insignificant; and in all cases the curves were readily completed by interpolation. I inspected the tidal observatory, between the 2nd and 9th January, assisted by Surveyor Dhondu Vinayek, who left Bushire on the 25th December, and arrived in Karachi on the 3rd January, and found the tide-gauge working well, and everything looking very neat and clean. I mentioned in my last year's annual report that in March 1893 the clerk had been directed to ascertain the condition of the bottom of the float-cylinder, and the communication, by means of monthly measurements inside and outside the cylinder taken from the level of the bed-plate, and to report any accumulation of mud to the Assistant Engineer, with a view to its immediate removal. The clerk took these measurements as ordered, but the cylinder had not been cleaned out, and I found that over two feet of mud had been allowed to accumulate within it. This accumulation was removed. The mud collects now in the cylinder more rapidly than in former years; I, therefore, directed that in future the cylinder should be cleaned out once every six months, and the condition of the mud outside the cylinder ascertained at the same time, with a view to its removal if necessary. These directions have been complied with. In March last, at the cleaning of the cylinder, no mud had collected inside it, but some dredging was necessary around the observatory; six months later, in September, a deposit of mud was removed from within the cylinder, but no external dredging was necessary. I had the bench-mark of reference protected by a strong wooden railing, and on finishing my inspection left everything in good order Afterwards, on the 13th February, a new graduated staff was set up. On the 17th of the same month Mr. Belcham arrived in Karachi, and, before going on to Bushire, took the opportunity to inspect the observatory; he also inspected it on his return from Bushire. The anemometer has given very perfect records; but the aneroid has been repeatedly out of order, and its clock has not being going for the last month, namely, since the 3rd September; during the preceding six months it had become very insensitive and its registrations useless, and another aneroid must be substituted for it at next inspection. The tidal observatory clerk, Jhamat Mal, performs his duties very satisfactorily. Mr. Morris, the Port Engineer, has the kindness to generally superintend the work, and under his direction his Assistant Engineer, Mr. Dharam Sing, immediately supervises the tidal observatory. For many years Mr. Dharam Sing has been of great assistance, visiting the observatory frequently, taking measurements for determination of zero when required, and providing for all necessary cleaning and repairs.

Porbandar.—The State Engineer of Porbandar, Kathiáwár, wrote to me in January stating that he had been taking tidal observations at the port at 15 minute intervals for a year, and asking me where he could get forms and instructions for the reduction of his observations. I sent him the information he asked for, together with a specimen set of the forms required for one year's observations at a port, which were to be returned to me after examination, and I offered to undertake the calculation, if he should feel disinclined to do so, on account of the labour involved, and incorporate the results in

the tide tables for the Indian Ports, as had been done in the case of the tidal observations at Port Albert Victor, which were carried out under the direction of Mr. Proctor-Sims, the State Engineer of Bhávnagar. In May, I received a letter from the Administrator, Porbandar State, enquiring whether one year's observations were sufficient for the compilation of an accurate tide-record of a port, and asking whether I thought it would be advisable to continue the observations for another year, or whether those taken up to date were sufficient for all practical purposes. I replied that the observations taken were sufficient for the determination of a good value of the mean sea level, and of the mean and extreme tidal ranges, etc., if the tide-gauge had been connected by spirit levelling with a bench-mark on shore; but that I was unable to say whether they were sufficient for the compilation of an accurate tide-record of a port, or for all practical purposes until I knew exactly what the State Engineer wished to deduce from them. I added that they would suffice for the preparation of tide-tables, similar to those for Port Albert Victor and Okha Point in our publications, and that I should be happy to make an arrangement at Porbandar, such as that now being made at Port Albert Victor (where it is intended to supplement the existing observations by a more extended series of observations, to be taken with a self-registering tide-gauge) if, after preparing tide-tables from the State Engineer's existing observations, such an arrangement should seem advisable to the State authorities. With reference to the question of extending the State Engineer's present series of observations for a second year, I stated that I thought such an extension would be desirable, especially if it were contemplated to have tide-tables prepared from his first year's observations. On the 26th June, the Administrator wrote informing me that it had been determined to continue the observations at Porbandar until the 31st December 1894.

Bhávnagar.—At this station, the self-registering tide-gauge has continued working well, only a few short and unimportant interruptions in the registrations having occurred since the beginning of the year. On the 14th January, the bolt of the air-cock handle came off and was not replaced for 6 hours, consequently the tidal curve remained unrecorded for that time. There was imperfect communication for three hours, on the 15th February, owing to a leak in the communication pipe, and for about 12 hours, on the 5th March, through the pipe having become choked. The cord supporting the counterpoise weight of the pencil broke at 6-15 o'clock on the evening of the 19th February, and work was re-started at 7 o'clock on the following morning. The usual 5 years' series of observations were completed in January; but the State Engineer had reasons for continuing them until July; and in August Surveyor Dhondu Vinayek went to Bhávnagar, took zero measurements, and carried out the usual details of an inspection, dismantled and cleaned the instruments, which are the property of the Bhávnagar State, handed them over to the State Engineer, and closed the observatory. He also set up a graduated staff, to which personal observations will be taken, and, at Captain Godrich's request, set its zero to correspond with the zero of the tide-gauge, instead of making it agree (as is customary) with the datum of the tide-tables.

The aneroid worked without an actual interruption until December. During that month it stopped for a short time on three occasions, and in January it stopped once. These stoppages were unimportant; but the instrument is not sufficiently sensitive; and the diurnal variation is not properly recorded on the diagrams.

The anemometer has worked admirably, and without a single interruption.

The success which has attended the tidal observations at Bhávnagar has been due to the excellent arrangements of Mr. Proctor-Sims, the State Councillor and Engineer, to whom I would tender my cordial thanks for his unvarying and kind co-operation. My thanks are also due to his Nautical Assistant, Captain F. M. Godrich, who has had the immediate superintendence of the tidal observatory.

Apollo Bandar, Bombay.—The tidal registrations at this station have been most satisfactory, and have proceeded without a break throughout the year under report; in fact, the tide-gauge has worked without a single failure since November 1886—an admirable record. The graduated staff set up last year has fully answered its purpose. In addition to two visits paid to the observatory while passing through Bombay, I made the regular annual inspection of it in January, being assisted as usual by Surveyor Dhondu Vinayek. The observatory was found, as always, kept in very good order by the clerk, J. Fernandez; and at the close of the inspection the tide gauge was left clean and in perfect adjustment. On the 4th June, the tide-gauge well was cleaned out, and three cart loads of mud removed from it. Auxiliary instruments are not employed at either of the Bombay tidal observatories, as the necessary meteorological observations are taken at the Colaba Observatory.

Prince's Dock, Bombay.—The self-registering tide-gauge, with short upright drums, of the pattern in use at this station only, has worked remarkably well, although its performance is inferior to that of the ordinary instrument of Newman's pattern, with one long horizontal drum, which is capable, as shown in the preceding paragraph, of working for years without a single failure. Interruptions to the registrations took place during the year under report, owing to the following occurrences: The cord of the counterpoise weight broke on the 6th October, and 9 hours elapsed before it was repaired. On the 5th November, owing to its flimsiness, the diagram paper was pierced twice by the zero-pencil; but the latter released itself after an hour on both occasions. On the 7th of the same month, another small tear was made by the pencil, on this occasion, in

consequence of a crease or wrinkle in the diagram paper. The upper edge of the diagram paper was twisted for about 5 hours on the 7th December, when the clerk set it right. The float-band broke on the 27th February and was repaired on the following day, the interruptions so caused to the registrations lasting for 17 hours. Lastly, the driving clock stopped at 1-47 P.M. on the 21st July, and was repaired and set going again at about 9-30 A.M. on the 23rd of the same month. I inspected the observatory in January, being assisted, as usual, by surveyor Dhondu Vinayek, who carried out the cleaning, measurements, etc., and in March, after the breaking of the float-band, I made an inspection by myself, and took the required sets of measurements for determinaition of zero. At both inspections the tide-gauge was left in perfect order. The new zero-pencil holder, I contrived and fitted to the tide-gauge in April 1893, answers well, and much better than its predecessor; but its action would be more satisfactory, and the tide-gauge would be decidedly improved if the diagram paper were stronger and tougher, of a smoother surface, and freer from small hairs. At the January inspection a chiselled inscription was added to the bench-mark of reference. The screening off of the portion of the ground-floor of the light-house which forms the tidal-observatory, by means of a corrugated iron partition put up since July 1893, as then requested, is a great improvement, giving privacy, and protecting the observatory from the intrusion of unauthorised visitors. The clerk has been performing his duties satisfactorily.

I am indebted to Mr. P. Glynn Messent, the Acting Engineer to the Port Trust, who, during Mr. Squire's absence on leave throughout the year under report, has exercised a general control over the working of both the Bombay tidal observatories.

Cochin.—I am much obliged to Mr. H. Woodhouse, the Port Officer at this station, for having furnished to me regularly the monthly tabulated comparisons between the values given in the tide-tables, and the times and heights of high and low water obtained daily from readings to a graduated staff, or tide-pole, in the manner described in my two preceding annual reports. The height predictions contained in the tide-tables for 1893 agree very closely with the the actuals; but, assuming the correctness of the Port Officer's time, the time predictions were on the average about 30 minutes too early. During 1894, the height comparisons have been as satisfactory as ever, and there has been an improvement in the time comparisons, their apparent average error up to date being only about 20 minutes too early. Even this apparent error may, possibly, somewhat exaggerate the real error of the tide-tables; for it must be borne in mind that a few minutes' error in local time is quite possible, and that although heights, except in rough weather, can be accurately observed, the times of high and low water cannot be determined with very great precision by observations to a tide-pole. When the time of high and low water is measured by two independent trained observers from the tidal curve traced by a self-registering tide-gauge, their permissible difference is 10 minutes; and at least as great an error may reasonably be allowed when readings are taken from so rough an appliance as a tide-pole.

Minicoy.—The tidal observations at this remote island-station have been again very satisfactory, and no mischief has been done by the islanders to Survey property during the period under report. Owing to the isolation of Minicoy (which is only visited at regular intervals by the steamer carrying the Superintendent, Imperial Light Service, from Ceylon), it is not possible on each 1st October to report on what occurs there during the exact period included in the Survey year, and the following remarks will deal with observations from the 10th July 1893 to the 3rd September 1894. Nothing was reported to have occurred affecting the tide-gauge until the 29th January 1894, on which day the brass loop at the bottom of the float, to which the counterpoise chain is attached, broke; and the clerk repaired it temporarily with copper wire, renewing at the same time about 4 inches of the chain which he found much corroded. This piece of work only occupied 28 minutes, and no hourly readings were lost. On the 10th March, 47 minutes were spent in substituting a new copper loop for the broken brass one, and on this occasion also no hourly readings were lost. On the 19th June, after the commencement of the S. W. monsoon, the counterpoise chain got caught near the bottom of the float cylinder and parted, but was repaired, and 6 feet of it renewed by the clerk in a little over an hour. For about four hours, on the 19th July, the pencil marked a straight transverse line on the diagram just over the central groove in the drum. The clerk, therefore, had the float-cylinder cleaned out, and a large quantity of sand and rubbish was taken out of it. Two days later sand was found to have accumulated to a thickness of about 6 inches round the bottom of the float-cylinder, and was removed without interrupting the work. At the same time a piece of the stone supporting the cylinder was found to have broken off, and the water was consequently flowing too freely in and out of the cylinder, and causing excessive oscillation of the pencil on the drum. The water was too rough at the time to admit of work being done at the bottom; but on the following morning the stone was mended, and it was then found that sand had again collected round the bottom of the cylinder to a thickness of about 4 or 5 inches, retarding the water communication and, consequently, the free movement of the pencil on the drum. Observations had, therefore, to be suspended for a little under 3 hours, during which time two holes in the float-cylinder were opened with difficulty, all shell fish on the inner and outer surface of the cylinder were scraped off, and the accumulation of sand was removed. Finally, a little more than an hour was spent in cleaning the inside of the float-cylinder on the morning of the 3rd September. It will be noticed that, with the exception of the breakage of the brass loop at the bottom of the float, due to continued corrosion, the interruptions to the registrations occurred during last S. W. monsoon, at which time the sea was rough, and that all the interruptions were trivial. Zero measurements, taken periodically by the clerk, show that the tide-gauge has remained in good adjustment.

The registrations of the aneroid have been uninterrupted, and most satisfactory throughout the whole period under report.

The anemometer has worked very well. Some trouble from ants was experienced, similar to that mentioned in my last annual report. On four days, in the early part of September 1893, some small black ants were found in the mechanism, and on three of these occasions they stopped its working for a short time. On the 12th of that month, the clerk applied some carbolic acid, mixed with a little cocoanut oil, round the instrument, since when the ants have kept away. On the 3rd October, the anemometer was transferred 8 feet to the south, to a masonry column 10½ feet high, which the clerk had built according to instructions; the interruption to the registrations, so caused, lasting less than 3½ hours. During December there were three interruptions to the registrations, the first two caused by the cups sticking, and the last by rust collecting on the velocity shaft. No other interruptions occurred.

The standard sun-dial has been used to rate the clocks, the clerk having taken periodical observations with it for that purpose. This instrument, and the mercurial barometer and rain-gauge, were in good order throughout the whole period under report.

I had arranged with Commander A. Channer, R.N., Superintendent, Imperial Light Service, Ceylon and Minicoy, that an inspection party, consisting of a surveyor and two men, should sail with him to Minicoy in January; but he changed his plans, and did not find it convenient to take the party there until the end of March. The inspecting party, consisting of Surveyor Dhondu Vinayek, the senior mechanic, and one peon, sailed with Commander Channer from Colombo, on the 31st March, and returned to that place with him from Minicoy, on the 12th May, just before the burst of the S. W. Monsoon. During his inspection, Surveyor Dhondu Vinayek, as directed, strengthened the support of the tidal observatory house. He had new piles carefully sunk into the sand and attached to the observatory, without interfering with the observations or altering the level of the bed-plate, and the structure ought now to last to the time when the series of observations will end, without requiring further strengthening. He also thoroughly repaired the communication bridge and ladder. The several instruments were found to have been kept, as usual, in excellent order: they were thoroughly cleaned, and left in proper adjustment. The clerk continues to take a great interest in his work, and to perform all his duties in a very satisfactory manner: the assistant clerk is also well versed in his duties, and both men work together in harmony. The special daily observations taken for the Meteorological Reporter to the Government of India have been continued satisfactorily, and transmitted to Calcutta, as usual. No characteristic storm passed over the island during the period under report.

I have already mentioned my obligations to Commander Channer, and I wish to state here that my thanks are also due to the Collector of Malabar for his co-operation, ever since the commencement of the tidal operations at Minicoy.

Tuticorin.—Captain Baker, the Port Officer at this station, kindly continues to send me every month the daily times and heights of high and low water, obtained from readings taken during day-light to a graduated staff. The results of the comparisons between his values and the corresponding predictions in the tide-tables continue to be most satisfactory.

Colombo.—The Engineer in charge of the Harbour works at this station has the goodness to furnish observed tidal values for comparison with the values contained in the tide-tables. The comparisons have been made for the year 1893, and, in the case of both times and heights, are very satisfactory.

Galle.—Owing to the smallness of the tidal range, and the roughness of the sea at this station, daily verificatory observations are not taken; but Captain Blyth, the Master Attendant, undertook, as mentioned in my last annual report, to test the tide-tables daily, and report any marked difference occurring between actual and predicted tides. As yet no report has been received from him.

Trincomalee.—The tidal observations at this station have continued to be highly satisfactory; and the registrations of the tide-gauge may be considered practically perfect throughout the year under report, there being only one actual flaw in them, occasioned by the pencil failing to mark the diagram for 6 hours, on the 12th November. The graduated staff used for comparing the level of the water inside and outside the float-cylinder was washed away in June, and was replaced by a spare one kept in reserve in the observatory. The former, which was picked up, was repainted, and is now kept in reserve.

The aneroid has worked well on the whole. Its driving clock stopped eleven times during the year under report; but none of these stoppages lasted for more than a few hours.

The performance of the anemometer was not satisfactory. Complete stoppages of the instrument were not numerous, only seven having occurred during the year; but the clock-time is open to suspicion for 3½ months at the beginning of the year, and there is no certainty that the direction of the wind in the same time was correctly recorded. Since the 20th March, the velocity gear has not worked, and another anemometer should be set up at next inspection.

The mercurial barometer and the rain-gauge have been kept in good order throughout the year, and their registrations are complete.

Mr. Belcham inspected the observatory, between the 16th and 26th January, and found the tide-gauge and aneroid working well, although very dirty owing to coal dust having got into the observatory cabin three or four days before his arrival. He found the ruby forming the top pivot of the balance wheel of the driving clock of the tide-gauge cracked; but the crack did not extend right across the stone. He set up the standard sun-dial on the pillar prepared for it, as mentioned in my last annual report, and instructed

the clerk in its use. He had some trouble in adjusting the aneroid (which is a good instrument of the new pattern), owing probably to the effect of the coal dust with which its mechanism had been clogged, and which it is impossible to keep completely out of the observatory when coaling is going on close by in the Naval Store Yard. The readings were sometimes very accordant with those of the mercurial barometer and at other times differed from them by as much as 0·03 inch. The marking of the pencil was also faint.

He found the clock and direction gear of the anemometer out of order, and the nut for securing the cups to the rod missing. He put the instrument to rights, and made an alteration in the adjustment and figuring of the diagrams, so as to make the daily record run continuously from top to bottom on each sheet.

He found the graduated staff decayed and useless; and set up a new one in its place: he also prepared a spare one as a reserve and left it in the observatory. At the end of his inspection he reported that all the instruments were in adjustment, and were left working well; and that the clerk had been thoroughly instructed in the use of the standard sun-dial, and had taken good independent observations with it, and had also been ordered to take similar observations at least twice a week for the future. The clerk understands all his duties, and has performed them satisfactorily throughout the year.

I am indebted to Mr. J. Forsey, the Naval Store-keeper, for his continued kindness in exercising a supervision over the tidal observations.

Madras.—The permanent tidal observatory at this station is being built; and, as regards the proposed resumption of tidal observations, I have nothing to add to my comments made above.

Cocanada.—In my notice of this station, in my last annual report, I gave figures showing large discrepancies between certain tidal heights as observed, and as predicted in the tide-tables, and mentioned the regrettable circumstance that tidal comparisons had been discontinued, and that, in future, I could only expect to receive, through the kindness of the Port Officer, particulars of such tidal discrepancies as should be sufficiently remarkable to attract his notice. No such particulars have been sent to me during the year under report.

Kidderpore.—At this station, the tide-gauge worked very well throughout the year, and its driving clock only stopped once for a few hours during that time; but on seventeen days in May, and nineteen days in June, the float-band stuck for a short time while the tide was about 9·5 feet above the zero of the gauge, this being, no doubt, due to a stud of the stud-wheel sticking in one of the holes of the float-band. The small portions of the tidal curves thus improperly recorded can be readily interpolated.

The aneroid only experienced five short stoppages; but its registrations have not been satisfactory; they have been largely in defect of the readings of the mercurial barometer, and although the diagrams indicate a rise and fall during day time, this indication was obtained by the clerk tapping the instrument, the pencil tracing almost a straight line during the night.

The anemometer, so far as its mechanism is concerned, has behaved well; its registrations of wind-velocity being uninterrupted, and its direction gear having only failed to mark on one day. Doubt, however, is thrown upon the registrations of this instrument, owing to the unauthorised action of the clerk, which I shall mention presently.

Mr. Belcham inspected the tidal observatory, from the 5th to the 10th December, and reported that, although otherwise in good order, the whole structure oscillated owing to the disturbance of the water caused by passing steamers, and he recommended that as the dock works were completed, a firmer and more permanent tidal observatory should be erected. He found the tide-gauge and anemometer, but not the aneroid, in proper adjustment, and he reported that on the day of his arrival, on paying an early visit to the observatory, he found the clerk changing the anemometer diagram at 8 A.M., instead of at noon, and making, nevertheless, the usual entry that the diagram was taken off at noon. On being questioned, the clerk said he had been adopting this procedure since the 3rd June 1893. (doubtless to avoid mid-day visits to the observatory), and Mr. Belcham noted in his report that the diagrams required correction from that day to the 5th December; he also admonished the clerk, and told him to be careful in future to change the diagrams at noon and to enter in his reports the facts as they occurred. All the instruments were cleaned, and at the end of his inspection Mr. Belcham reported that they were all in thorough order and adjustment. The aneroid, however, soon afterwards returned to its former unsatisfactory condition.

In consequence of Mr. Belcham's report of the instability of the observatory, I communicated with the Port Commissioners, with a view to having a well-designed observatory erected, close to the site of the present one, during the coming cold season. Mr. Belcham's proposed correction of the anemometer diagrams, from the 3rd June to 5th December 1893, could not be made in my office; for, on examining the diagrams taken off and put on, on the 3rd June, it was found that the former, which would have had the last four hours blank if the clerk's statement had been true, was marked by the spirals from top to bottom; and neither it nor any other diagram has any indication that it was taken off or put on, except at the regular hour of noon. For all that appears to the contrary, the clerk may have commenced his unauthorised action immediately after my own inspection of the observatory in January 1893 (mentioned in my last annual report); but unfortunately this cannot be ascertained from an inspection of the diagrams, and a doubt is thus cast on all the diagrams, from 11th January to the 5th December 1893, which may all require a correction of 4 hours.

Chittagong.—I am much obliged to Mr. Good, the Port Officer at this station, for having sent me personally observed tidal values for comparison with the values contained

in the tide-tables. The comparisons have been made for the year 1893 (excepting the month of January, for which values were not received) and, both as regards times and heights, are very satisfactory.

Akyab.—At this station, Captain Bishop is kind enough to continue supplying me with personally observed tidal values for comparison with the values contained in the tide-tables; for which I feel much obliged to him. His observations for height accord very closely, and his observations for time accord fairly well with the corresponding values contained in the tide-tables. According to his observations, the time predictions in the tide-tables appeared to be about 20 minutes too early during 1893, and during 1894, up to date, about 15 minutes too early. The errors may, possibly, be really less, however, for reasons similar to those given at the end of the paragraph on the Cochin observations.

Rangoon.—At this station, the self-registering tide-gauge worked well, except in January when there were several stoppages of the driving clock. On the 14th of that month, after a stoppage, the clerk's efforts to set the clock going again were unavailing, and it had to be removed for repairs. It was returned and set working on the 17th; but it soon took to stopping again, and on the last day of the month it stopped twice. It was again removed for repairs on the 1st February, and replaced on the 3rd of that month, since when it has experienced only two short stoppages.

This year, the registrations of the aneroid again show many interruptions and other defects. The instrument is insensitive, and its driving clock stopped 23 times, on each occasion for about 12 hours; the stoppages occurring generally between sun-set and sun-irse.

The anemometer has worked exceedingly well in its new position, mentioned in my last annual report, and its registrations have only two interruptions of 22 and 11 hours' duration, respectively, caused by the stopping of the driving clock.

It will be noticed that the interruptions to the working of the several instruments were caused exclusively by the stopping of their driving clocks; this may have been partly due to the tremulous motion communicated to the observatory at spring-tides, which ebb and flow with much force, and it may be necessary to stiffen further the bracing of the observatory; also, perhaps, to sever its rigid connection with the long bridge leading from it to the shore, through which it appears likely that shocks are occasionally communicated to it: the latter object would be effected by removing a small part of the outer end of the bridge, so as to have a small gap between it and the observatory, the gap to be crossed by means of a short wooden foot-way or planking, secured by one end to the observatory, the other end being allowed to rest loosely and move freely on the floor of the bridge.

Some trouble was occasioned by the inroads of rats. These animals gnawed their way into the tidal observatory, and, according to the clerk's account, completely destroyed the diagram of the aneroid containing the barometric observations for the week ending on the 2nd October 1893, and slightly injured the tidal-diagram in use on that day; they also partially destroyed a later aneroid-diagram, the remains of which were transmitted to my office by the clerk.

Mr. Belcham made an inspection of the observatory in two instalments, namely, from the 17th to the 20th December, and from the 1st to the 3rd of January: the interval between them being occupied by his visit of inspection to Diamond Island, already mentioned. Mr. Belcham reported that he found the Rangoon observatory in good order and the tide-gauge and anemometer working well, although the float-band of the former instrument had a kink near the 2·3 feet line. He had the kink smoothed out, and a small piece of spare band placed carefully over the damaged part to strengthen it. With the exception of the aneroid, he left all the instruments working well and in good adjustment. He also reported that the observatory clerk understands and does his work well, and keeps the observatory and the instruments clean and tidy.

I feel much obliged to Mr. Kynoch, Vice-Chairman of the Port Commissioners, and to Mr. Clementson, the Port Engineer, for their co-operation.

Moulmein.—Captain Dodd, the Port Officer at this station, has for the last eight and a half years been sending me regularly every month statements of the actual times and heights of high and low water observed daily under his direction, compared with the predicted values given in the tide-tables; and I feel very grateful to him for his long-continued help.

In 1893, the average errors both in time and height remained unchanged from what they were in the preceding year; but, I am glad to state, that during 1894, up to the present, they show a sensible decrease. The low water heights and times, which have been remarked on in former reports, were during last June, July, and August nearer the truth than they have been before. The values in feet and inches of the average excess of predicted heights above actual heights at low water, during the month of August for the seven years ending with 1893, may be found by turning to my two last annual reports. The average excess for August 1894, was 1 feet 1 inch, a value which compares very favourably with former values, being about half the excess for August 1893, and about a third the excess for August 1892. The comparisons between the actual and predicted tidal values taken at the tidal stations are sent regularly to Mr. Roberts, and the improvement he has now been able, with Captain Dodd's kind assistance, to make in the Moulmein tide-tables is very marked, and will, I hope, continue.

Mergui.—At this station all the instruments have worked well. The chain of the counterpoise weight of the tide-gauge caught in the float-cylinder twice in one day for about 3 hours each time, and a few stoppages of the driving clock occurred, owing to the

vibration of the observatory which, as it neared its time for being closed, had been growing very shaky; but none of the interruptions so caused to the registrations are of any importance. The driving clock of the aneroid stopped once only; and the registrations of this instrument have continued to be most satisfactory, and closely accordant with the readings of the mercurial barometer. This aneroid is the only really satisfactory instrument of the old pattern at present in use in the Indian tidal observatories. The anemometer has again worked without a single interruption; and the standard sun-dial has been most useful, the clocks having been kept, by its means, to correct time. The usual series of 5 years' tidal observations were completed towards the end of March, at which time Mr. Belcham was at Bushire and Surveyor Dhondu Vinayek on his way from Poona to Minicoy. I have already mentioned how the visit of the latter to Minicoy (and consequently to Mergui) was delayed for more than two months. From Minicoy, Surveyor Dhondu Vinayek proceeded, *viâ* Colombo, to Rangoon, where he took some verificatory zero-measurements, and went on by the first steamer to Mergui, arriving there on the 4th June, after the commencement of the south-west monsoon. He reported that on his arrival in Mergui he found all the instruments working well; but the piles of the tidal observatory were much decayed; and the chain of the counterpoise weight of the tide-gauge had broken and had disappeared, with the exception of a length of 4 feet which hung below the counterpoise weight. He found the preponderance of the float thus diminished by 1lb; but the value of the working zero, as determined by his measurements, did not appear to be sensibly affected. Between the 4th and the 12th June he made a regular inspection of the tidal observatory, dismantled, cleaned, and packed up the instruments and sent them to Poona, with the exception of the mercurial barometer which he afterwards took to Rangoon and left in the transit observatory with the instruments which are stored there for future use at Diamond Island. He also fixed a graduated staff or tide-pole to one of the piles of the barrier at the head of the pier, mentioned in my annual report for 1890-91, and set its zero to correspond with the datum of the tide-tables. He took over all the records, for conveyance to Poona, and closed the observatory.

I am much indebted to Mr. H. G. Batten, the Deputy Commissioner of Mergui, for having most kindly superintended the tidal observations ever since 1890, and for having undertaken to report to me from time to time any cases he may notice in which the predictions contained in the tide-tables do not agree with the actuals observed by means of the graduated staff.

Port Blair.—The observations at this station have been proceeding steadily. The float-cylinder of the tide-gauge has been cleaned periodically and the communication kept free throughout the year, only one slight irregularity from retarded communication having occurred. The tide-gauge has worked remarkably well, and there has been only one interruption of 13 hours to its registrations. During rough weather near the end of October, part of the wooden enclosure protecting the float-cylinder was washed away, but it was promptly repaired, and no further damage occurred.

The aneroid has worked with only one stoppage of 11 hours' duration; but it is not sufficiently sensitive to give good registrations.

The anemometer, which was reported upon unfavourably in my last annual report, continued faulty, and, towards the end of November, was replaced by another anemometer the registrations of which have been good; they only had the following breaks:—On three days in January the velocity spiral failed to mark the diagram; on the 6th March the clerk forgot to gear the barrel and thus lost the observations for 24 hours; and, lastly, the driving clock stopped for 22 hours on the 6th September.

Mr. Belcham inspected the observatory from the 24th to the 30th November, and reported that he found it in excellent order and the tide-gauge working well: but that neither the aneroid nor the anemometer, although at work, were in a satisfactory condition. The float of the tide-gauge required repairing, and the gold wire of the aneroid, which was too thick, required to be changed for a finer wire. This was done; but although the readings of the aneroid were improved by the substitution, they are not satisfactory. Mr. Belcham brought with him from Poona an anemometer to replace the faulty instrument already mentioned, which he found to be recording much less than the true velocity of the wind. The substitution was made on the 27th November, and the old instrument after being cleaned was enclosed in a case and left in reserve, so as to be available if the newly erected instrument should get out of order. He also set up a standard sun-dial on the pillar which had been prepared for it as mentioned in my last annual report; and instructed the clerk in the use of the instrument. At the close of his inspection, Mr. Belcham reported that all the instruments were clean and in good order, and working well, and that the clerk had been keeping them clean and had been performing his duties satisfactorily. I regret that I am obliged to repeat *verbatim* what I wrote on the subject of clerks at Port Blair in my last annual report, namely, this: "Sheik Mohamed, the tidal-observatory clerk, has been performing his duties very satisfactorily, I consider, however, that an assistant clerk is necessary at a station so isolated as Port Blair, and I requested Captain Brookes to appoint one, if possible. I have not as yet heard that the appointment has been made." I wrote to Mr. Brookes on this subject on the 18th of last month, saying that I should be glad if the appointment of the assistant clerk could be made as soon as possible, and that the man selected should be instructed in his duties before the next annual inspection of the observatory.

The observations with the standard sun-dial were continued from the time of Mr. Belcham's inspection to the 6th March, when the clerk appeared to grow tired of taking them, and to think it easier to rely exclusively for the rating of his clocks on steamer time. On discovering this I wrote a letter to Mr. Brookes (on the 30th March) requesting

him to make the clerk take sun-dial observations at least once a week, in reply to which he informed me during the following month that the clerk was setting the tide-gauge clock by steamer time. As this was what I was objecting to, I had to write to him again, on the 9th May, repeating my request; and eventually, on the 24th June, the sun-dial observations were resumed, and are now being continued by the clerk with regularity.

Since the date of my last annual report, the Port Officer and his establishment were moved from Ross Island across the harbour to Aberdeen. In consequence of the inconvenience and loss of time to the clerk through having according to a new arrangement to take his reports for the Port Officer's inspection and signature, I suggested to the Chief Commissioner in January that the tidal observatory should be placed, as formerly, under the supervision of Mr. Brookes, who continues to reside on Ross Island, and in February the Chief Commissioner informed me that Mr. Brookes resumed charge of the observatory on the 9th of that month.

I feel much obliged to Mr. Brookes (now 2nd Assistant Superintendent, Port Blair) who has had the supervision of the tidal observatory during the past twelve years, for the great assistance he has thus afforded to the operations.

If the unavoidable suspension of the tidal observations for four months at Bushire be excepted, the operations have been very successful during the year under report; and at the present date the work is proceeding most satisfactorily at all the tidal observatories without exception.

With the exception of the tidal observatories to be opened during next Survey year at Madras and Diamond Island, and possibly, though hardly probably, at Port Albert Victor and Porbandar, no new tidal observatories will be required until after the termination of the operations at Minicoy and Trincomalee in January 1896. It will then be convenient to continue the extension of the minor tidal stations. In 1889 the eventual establishment of tidal observatories at the following new stations was sanctioned:—Acheen, Bangkok, Perim and Suez. On the Western Coast of India one new tidal station at least is required to the north of Bombay, and another to the south, near Mangalore, if a suitable site can be found there. In Burma, the tidal station of Mergui, where the observations have recently been finished, is situated at the northern end of the Mergui Archipelago, and its usefulness cannot extend southwards owing to the numerous islands of the Archipelago which greatly complicate the tides. It would be advantageous to have a tidal station at the southern end of the Archipelago in about latitude 10°, near Victoria Point, and another on the coast of the Gulf of Siam in Siamese territory near Chum-phaun, which I have reason to believe the Siamese Government would be willing to erect and maintain (see my annual report for 1886-87). These two observatories could be easily connected by spirit-levelling along the new road up the Pakchan creek and across the Isthmus of Kra, and their establishment would provide us with tidal observations in British waters at the southernmost extremity of the province of Burma, and with unrivalled means of comparing the tides on both sides of the Malay Peninsula.

The experience accumulated during past years has, I hope, resulted in the tidal observatories being now built on very convenient patterns. The capacity of the float-cylinders has of late years been somewhat enlarged; and the plan of bending the communication pipe so as to form a siphon, although described in books, is never now adopted in India. Of the self-registering instruments employed at the observatories, the tide-gauges of Newman's pattern with long horizontal drum, and means for altering as desired the scale on which the tidal curves are delineated, have answered their purpose admirably, and are in use at all the tidal observatories except Prince's Dock; they are now made by Messrs. Légé & Co., who have introduced some minor improvements in the mechanism. The tide-gauge at Prince's Dock has short upright drums, and the points in which it is inferior to the instrument in general use have been particularised in the remarks on that observatory in this report, as well as in that for 1892-93, and for 1891-92. The aneroids are not satisfactory, with the exception of one instrument of old pattern which has been working until recently at Mergui and three new aneroids by Messrs. Légé & Co. which are now working at Aden, Minicoy, and Trincomalee; and our chief reliance is placed on the mercurial barometers, which are read four times a day. The index errors of some of the mercurial barometers have not been recorded, and the inspecting officers should take the first opportunity of supplying this omission; by comparing these instruments with standards, and sending their index errors and their heights above mean sea-level to the Poona office, for record. The anemometers, as I had occasion to remark in my annual report for 1891-92, are unsatisfactory instruments. There is no means, available at a tidal observatory, for testing the accuracy of their measurements of wind-velocity: there is much friction between the parts, and the toothed wheels and spirals are constantly wearing out and requiring repairs. After such repairs, whatever the instrument may have been originally, there can be no certainty of its being a true recorder of wind-velocity.

Reduction of the Tidal Observations and extra Tidal work.

The observations for one year at 13 tidal stations have been reduced, and the tabulated values of the tidal constants so obtained are appended. Another table showing the variation in height of the sea-level, from the general mean height at all the permanent and closed tidal observatories, for each calendar year of the tidal operations, is also appended, to enable comparison to be made between the values at each station. The computations for each tidal observatory commence now on January 1st. Should a new observatory be established on another date, the first year's calculations only would be made from that date, but those for the second and subsequent years would begin on January 1st.

Values of the Tidal Constants, Aden, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Aden ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations :—

Short Period Tides.

A_0=5·808 feet.

S_1	H = R =	·096	M_6	R =	·006	Q_1	R =	·141	T_2	R =	·061
	κ = ζ =	178°·51		ζ =	252°·65		ζ =	209°·95		ζ =	223°·53
S_2	H = R =	·673		H =	·006		H =	·121		H =	·061
	κ = ζ =	244°·73		κ =	358°·73		κ =	25°·22		κ =	223°·40
S_4	H = R =	·008	M_8	R =	·002	L_2	R =	·036	$(MS)_4$	R =	·018
	κ = ζ =	244°·08		ζ =	339°·44		ζ =	344°·03		ζ =	159°·18
S_6	H = R =	·005		H =	·002		H =	·030		H =	·019
	κ = ζ =	206°·57		κ =	120°·89		κ =	220°·22		κ =	194°·54
S_8	H = R =	·001	O_1	R =	·767	N_2	R =	·415	$(2SM)_2$	R =	·023
	κ = ζ =	275°·71		ζ =	188°·89		ζ =	217°·91		ζ =	140°·03
				H =	·656		H =	·429		H =	·024
				κ =	37°·58		κ =	219°·84		κ =	104°·67
M_1	R =	·071	K_1	R =	1·442	λ_2	R =	...	$2N_2$	R =	·079
	ζ =	220°·80		ζ =	206°·54		ζ =	...		ζ =	203°·17
	H =	·050		H =	1·305		H =	...		H =	·082
	κ =	16°·96		κ =	34°·54		κ =	...		κ =	171°·68
M_2	R =	1·487	K_2	R =	·236	ν_2	R =	·063	(M_2N)	R =	·039
	ζ =	191°·36		ζ =	40°·03		ζ =	65°·63		ζ =	83°·76
	H =	1·538		H =	·183		H =	·065		H =	·041
	κ =	226°·73		κ =	235°·64		κ =	170°·68		κ =	121°·06
M_3	R =	·014	P_1	R =	·410	μ_2	R =	·085	$(M_2K_1)_3$	R =	·039
	ζ =	347°·75		ζ =	221°·97		ζ =	110°·82		ζ =	153°·84
	H =	·014		H =	·410		H =	·091		H =	·036
	κ =	220°·80		κ =	30°·74		κ =	181°·55		κ =	17°·20
M_4	R =	·004	J_1	R =	·097	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =	193°·24		ζ =	204°·77		ζ =	...		ζ =	109°·59
	H =	·004		H =	·084		H =	...		H =	·006
	κ =	263°·96		κ =	64°·86		κ =	...		κ =	352°·32

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide . . .	·043	282°·89	·049	316°·32
„ fortnightly „ . . .	·047	215·34	·033	13·31
Luni-solar „ „ . . .	.007	104·95	·007	69·59
Solar annual „ . . .	.431	79·63	·431	0·87
„ semi-annual „ . . .	.105	330·73	·105	173·20

Values of the Tidal Constants, Maskat, 1893-94.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893-94 observations at Maskat ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893-94 observations :—

Short Period Tides.

A_0=7·694 feet.

S_1	H = R =	·111	M_6	R =	·002	Q_1	R =	·140	T_2	R =	...
	κ = ζ =	182°·32		ζ =	10°·31		ζ =	168°·71		ζ =	...
S_2	H = R =	·779		H =	·003		H =	·119		H =	...
	κ = ζ =	305°·81		κ =	6°·15		κ =	41°·59		κ =	...
S_4	H = R =	·004	M_8	R =	·003	L_1	R =	·038	$(MS)_4$	R =	·014
	κ = ζ =	3°·90		ζ =	145°·18		ζ =	103°·52		ζ =	93°·47
S_6	H = R =	·002		H =	·004		H =	·031		H =	·014
	κ = ζ =	313°·26		κ =	19°·64		κ =	294°·91		κ =	332°·08

Short Period Tides—contd.

A_0=7·694 feet.

S_8	H =	·003	O_1	R =	·770	N_2	R =	·488	$(2SM)_2$	R =	·006
	R =			ζ =	24°·36		ζ =	163°·39		ζ =	182°·96
	κ = ζ =	51°·34		H =	·657		H =	·505		H =	·006
				κ =	40°·52		κ =	258°·73		κ =	304°·35
M_1	R =	·039	K_1	R =	1·402	λ_2	R =	...	$2N_2$	R =	·086
	ζ =	21°·67		ζ =	175°·62		ζ =	...		ζ =	259°·72
	H =	·029		H =	1·268		H =	...		H =	·089
	κ =	105°·57		κ =	39°·31		κ =	...		κ =	211°·79
M_2	R =	2·001	K_2	R =	·263	ν_2	R =	·130	$(M_2N)_4$	R =	·048
	ζ =	37°·48		ζ =	32°·53		ζ =	324°·18		ζ =	4°·15
	H =	2·071		H =	·203		H =	·134		H =	·051
	κ =	276°·10		κ =	299°·55		κ =	225°·52		κ =	338°·11
M_3	R =	·028	P_1	R =	·389	μ_2	R =	·069	$(M_2K_1)_3$	R =	·019
	ζ =	308°·10		ζ =	263°·83		ζ =	91°·92		ζ =	125°·80
	H =	·029		H =	·389		H =	·074		H =	·017
	κ =	306°·02		κ =	37°·15		κ =	209°·16		κ =	228°·10
M_4	R =	·007	J_1	R =	·083	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	353°·66		ζ =	23°·55		ζ =	...		ζ =	83°·80
	H =	·007		H =	·072		H =	...		H =	·005
	κ =	110°·89		κ =	29°·28		κ =	...		κ =	337°·34

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide	·055	219°·37	·062	2°·65
„ fortnightly „	·047	340·62	·033	6·91
Luni-solar „ „	·017	178·44	·018	299·83
Solar annual „	·168	130·89	·168	87·57
„ semi-annual „	·135	274·76	·135	188·13

VALUES OF THE TIDAL CONSTANTS, BUSHIRE, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Bushire; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations:—

Short Period Tides.

A_0=4·878 feet.

S_1	H =	·027	M_6	R =	·009	Q_1	R =	·124	T_2	R =	...
	R =			ζ =	113°·11		ζ =	310°·39		ζ =	...
	κ = ζ =	12°·48		H =	·010		H =	·107		H =	...
S_2	H =	·314		κ =	327°·67		κ =	237°·91		κ =	...
	R =										
	κ = ζ =	262°·33	M_8	R =	·003	L_2	R =	·031	$(MS)_4$	R =	·038
S_4	H =	·009		ζ =	105°·95		ζ =	1°·87		ζ =	4°·24
	R =			H =	·003		H =	·027		H =	·040
	κ = ζ =	136°·82		κ =	32°·03		κ =	227°·30		κ =	75°·76
S_6	H =	·001	O_1	R =	·702	N_2	R =	·181	$(2SM)_2$	R =	·010
	R =			ζ =	337°·25		ζ =	99°·39		ζ =	180°·23
	κ = ζ =	36°·87		H =	·601		H =	·187		H =	·010
S_8	H =	·002		κ =	252°·97		κ =	182°·71		κ =	108°·71
	R =										
	κ = ζ =	297°·65	K_1	R =	·955	λ_2	R =	...	$2N_2$	R =	·037
				ζ =	127°·36		ζ =	...		ζ =	349°·88
M_1	R =	·039		H =	·865		H =	...		H =	·039
	ζ =	61°·52		κ =	284°·58		κ =	...		κ =	84°·99
	H =	·026									
	κ =	231°·01	K_2	R =	·157	ν_2	R =	·024	$(M_2N)_4$	R =	·015
				ζ =	150°·05		ζ =	74°·15		ζ =	91°·19
M_2	R =	·868		H =	·122		H =	·025		H =	·016
	ζ =	138°·96		κ =	284°·09		κ =	206°·36		κ =	246°·03
	H =	·897									
	κ =	210°·48									

Short Period Tides—contd.

A_0=4·878 feet.

M_8	R =	·041	P_1	R =	·254	μ_2	R =	·009	$(M_2K_1)_3$	R =	·127
	ζ =	157°·56		ζ =	74°·68		ζ =	251°·57		ζ =	219°·73
	H =	·043		H =	·254		H =	·009		H =	·119
	κ =	84° 84		κ =	274°·02		κ =	34°·61		κ =	88°·47
M_4	R =	·037	J_1	R =	·050	R_2	R =	...	$(2M_2K_1)_3$	R =	·114
	ζ =	233°·29		ζ =	155°·23		ζ =	...		ζ =	67°·59
	H =	·040		H =	·044		H =	...		H =	·111
	κ =	16°·34		κ =	299°·23		κ =	...		κ =	53°·41

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·024	317°·89	·027	306°·10
„ Fortnightly „	·069	95·09	·049	155·18
Luni-Solar „ „	·124	145·70	·128	74·18
Solar-Annual „	·414	254·18	·414	144·85
„ Semi-Annual „	·124	60·46	·124	201·79

VALUES OF THE TIDAL CONSTANTS, KARACHI, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Karachi; and also the *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=7·203 feet.

S_1	H = R =	·102	M_6	R =	·040	Q_1	R =	·141	T_2	R =	·112
	κ = ζ =	189°·63		ζ =	92°·05		ζ =	217°·91		ζ =	294°·00
S_2	H = R =	·956		H =	·045		H =	·120		H =	·112
	κ = ζ =	323°·60		κ =	202°·58		κ =	35°·51		κ =	293°·93
S_4	H = R =	·009	M_8	R =	·002	L_2	R =	·050	$(MS)_4$	R =	·035
	κ = ζ =	14°·68		ζ =	70°·02		ζ =	51°·77		ζ =	296°·41
S_6	H = R =	·010		H =	·002		H =	·042		H =	·036
	κ = ζ =	297°·35		κ =	217°·39		κ =	288°·65		κ =	333°·26
S_8	H = R =	·001	O_1	R =	·772	N_2	R =	·582	$(2SM)_2$	R =	·019
	κ = ζ =	149°·04		ζ =	196°·28		ζ =	273°·12		ζ =	148°·19
				H =	·660		H =	·603		H =	·020
				κ =	46°·51		κ =	277°·33		κ =	111°·35
M_1	R =	·068	K_1	R =	1·456	λ_2	R =	...	$2N_2$	R =	·077
	ζ =	238°·37		ζ =	217°·98		ζ =	...		ζ =	238°·83
	H =	·048		H =	1·318		H =	...		H =	·080
	κ =	35°·26		κ =	45°·92		κ =	...		κ =	210°·41
M_2	R =	2·496	K_2	R =	·329	ν_2	R =	·076	$(M_2N)_4$	R =	·066
	ζ =	257°·00		ζ =	118°·59		ζ =	120°·41		ζ =	218°·39
	H =	2·582		H =	·255		H =	·078		H =	·071
	κ =	293°·84		κ =	314°·08		κ =	227°·64		κ =	259°·45
M_3	R =	·033	P_1	R =	·409	μ_2	R =	·069	$(M_2K_1)_3$	R =	·069
	ζ =	118°·23		ζ =	232°·60		ζ =	183°·12		ζ =	206°·41
	H =	·035		H =	·409		H =	·074		H =	·064
	κ =	353°·50		κ =	41°·42		κ =	256°·81		κ =	71°·19
M_4	R =	·032	J_1	R =	·105	R_2	R =	...	$(2M^2K_1)_3$	R =	·027
	ζ =	278°·26		ζ =	221°·71		ζ =	...		ζ =	127°·39
	H =	·034		H =	·091		H =	...		H =	·027
	κ =	351°·95		κ =	80°·95		κ =	...		κ =	13°·14

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·039	352°·94	·044	25°·57
„ Fortnightly „	·059	236·26	·042	32·63
Luni-Solar „ „	·029	316·99	·030	280·15
Solar Annual „	·119	103·11	·119	24·28
„ Semi-Annual „	·182	331·28	·182	173·63

VALUES OF THE TIDAL CONSTANTS, BHAVNAGAR, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Bhávnagar; and also the *mean* values of the amplitudes (H) and of the epochs for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=22·550 feet.

S_1	H=R=	·111	M_6	R=	·237	Q_1	R=	·197	T_2	R=	·319
	κ= ζ=	200°·02		ζ=	29°·62		ζ=	268°·54		ζ=	129°·56
S_2	H=R=	3·592		H=	·262		H=	·168		H=	·319
	κ= ζ=	177°·02		κ=	141°·22		κ=	86°·71		κ=	129°·51
S_4	H=R=	·139	M_8	R=	·015	L_2	R=	·484	$(MS)_4$	R=	·697
	κ= ζ=	238°·96		ζ=	19°·03		ζ=	251°·33		ζ=	163°·25
S_6	H=R=	·018		H=	·017		H=	·408		H=	·721
	κ= ζ=	280°·93		κ=	167°·83		κ=	128°·37		κ=	200°·45
S_8	H=R=	·006	O_1	R=	1·135	N_2	R=	2·417	$(2SM)_2$	R=	·087
	κ= ζ=	303°·44		ζ=	237°·80		ζ=	110°·28		ζ=	32°·47
				H=	·970		H=	2·501		H=	·090
				κ=	88°·41		κ=	115°·04		κ=	355°·27
M_1	R=	·227	K_1	R=	2·612	λ_2	R=	...	$2N_2$	R=	·486
	ζ=	310°·89		ζ=	264°·34		ζ=	...		ζ=	72°·95
	H=	·159		H=	2·364		H=	...		H=	·503
	κ=	107°·96		κ=	92°·26		κ=	...		κ=	45°·27
M_2	R=	10·886	K_2	R=	1·163	υ_2	R=	·462	$(M_2N)_4$	R=	·356
	ζ=	98°·36		ζ=	335°·44		ζ=	320°·68		ζ=	49°·57
	H=	11·263		H=	·903		H=	·478		H=	·381
	κ=	135°·56		κ=	170°·90		κ=	68°·43		κ=	91°·53
M_3	R=	·064	P_1	R=	·672	μ_2	R=	·322	$(M_2K_1)_3$	R=	·182
	ζ=	345°·81		ζ=	284°·99		ζ=	200°·31		ζ=	292°·47
	H=	·067		H=	·672		H=	·345		H=	·170
	κ=	221°·61		κ=	93°·83		κ=	274°·71		κ=	157°·59
M_4	R=	·885	J_1	R=	·250	R_2	R=	...	$(2M_2K_1)_3$	R=	·122
	ζ=	81°·91		ζ=	304°·74		ζ=	...		ζ=	86°·76
	H=	·948		H=	·216		H=	...		H=	·118
	κ=	156°·31		κ=	163°·77		κ=	...		κ=	333°·24

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·082	343°·15	·093	15°·60
„ Fortnightly „	·054	201·21	·038	357·19
Luni-Solar „ „	·028	50·97	·029	13·77
Solar Annual „	·212	182·63	·212	103·80
„ Semi-Annual „	·194	332·93	·194	175·25

Values of the Tidal Constants, Bombay (Apollo Bandar), 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Bombay (Apollo Bandar); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=10·209 feet.

S_1	H = R =	·083	M_6	R =	·007	Q_1	R =	·141	T_2	R =	·186
	κ = ζ =	195°·52		ζ =	309°·23		ζ =	221°·92		ζ =	340°·66
S_2	H = R =	1·563		H =	·008		H =	·121		H =	·186
	κ = ζ =	5°·24		κ =	60°·97		κ =	40°·16		κ =	340°·60
S_4	H = R =	·016	M_8	R =	·002	L_2	R =	·054	$(MS)_4$	R =	·141
	κ = ζ =	236°·51		ζ =	72°·90		ζ =	77°·97		ζ =	9°·30
S_6	H = R =	·003		H =	·002		H =	·045		H =	·146
	κ = ζ =	135°·00		κ =	221°·89		κ =	315°·03		κ =	46°·55
S_8	H = R =	·001	O_1	R =	·781	N_2	R =	·961	$(2SM)_2$	R =	·042
	κ = ζ =	216°·87		ζ =	198°·10		ζ =	310°·01		ζ =	140°·95
				H =	·668		H =	·994		H =	·044
				κ =	48°·76		κ =	314°·84		κ =	103°·71
M_1	R =	·087	K_1	R =	1·548	λ_2	R =	...	$2N_2$	R =	·089
	ζ =	241°·11		ζ =	218°·02		ζ =	...		ζ =	273°·18
	H =	·061		H =	1·401		H =	...		H =	·092
	κ =	38°·20		κ =	45°·94		κ =	...		κ =	245°·60
M_2	R =	3·868	K_2	R =	·520	ν_2	R =	·114	$(M_2N)_4$	R =	·130
	ζ =	294°·88		ζ =	157°·73		ζ =	140°·25		ζ =	240°·78
	H =	4·002		H =	·403		H =	·118		H =	·140
	κ =	332°·13		κ =	353°·19		κ =	248°·07		κ =	282°·86
M_3	R =	0·75	P_1	R =	·415	μ_2	R =	·219	$(M_2K_1)_3$	R =	·109
	ζ =	160°·29		ζ =	233°·91		ζ =	223°·37		ζ =	277°·66
	H =	·079		H =	·415		H =	·234		H =	·102
	κ =	36°·17		κ =	42°·75		κ =	297°·87		κ =	142°·83
M_4	R =	·118	J_1	R =	·117	R_2	R =	...	$(2M_2K_1)_3$	R =	·073
	ζ =	268°·73		ζ =	221°·31		ζ =	...		ζ =	187°·57
	H =	·126		H =	·101		H =	...		H =	·071
	κ =	343°·23		κ =	80°·32		κ =	...		κ =	74°·15

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·031	11°·79	·035	44°·21
„ Fortnightly „ . . .	·077	223°·21	·054	19°·14
Luni-Solar „ „ . . .	·027	282°·11	·028	244°·86
Solar-Annual „ . . .	·097	50°·51	·097	331°·68
„ Semi-Annual „ . . .	·187	344°·45	·187	186°·77

Values of the Tidal Constants, Bombay (Prince's Dock), 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Bombay (Prince's Dock); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=8·253 feet.

S_1	H =		M_6	R =	·004	Q_1	R =	·139	T_2	R =	·194
	R =	·089		ζ =	60°·37		ζ =	218°·74		ζ =	339°·38
	κ = ζ =	199°·74		H =	·004		H =	·119		H =	·194
S_2	H = R =	1·591		κ =	178°·12		κ =	36°·98		κ =	339°·32
	κ = ζ =	3°·50	M_8	R =	·003	L_2	R =	·053			·126
S_4	H = R =	·028		ζ =	330°·95		ζ =	44°·77	$(MS)_4$	R =	7°·96
	κ = ζ =	225°·43		H =	·003		H =	·045		ζ =	·131
S_6	H = R =	·002		κ =	119°·94		κ =	281°·83		H =	45°·21
	κ = ζ =	122°·74	O_1	R =	·769	N_2	R =	·950		κ =	·052
S_8	H = R =	·002		ζ =	196°·61		ζ =	308°·07	$(2SM)_2$	R =	147°·68
	κ = ζ =	82°·57		H =	·658		H =	·983		ζ =	·053
				κ =	47°·27		κ =	312°·90		H =	110°·44
M_1	R =	·080	K_1	R =	1·532	λ_2	R =	...		κ =	·086
	ζ =	241°·04		ζ =	216°·58		ζ =	...	$2N_2$	R =	261°·15
	H =	·056		H =	1·387		H =	...		ζ =	·089
	κ =	38°·12		κ =	44°·50		κ =	...		H =	233°·57
M_2	R =	3·924	K_2	R =	·508	ν_2	R =	·107		κ =	·139
	ζ =	292°·22		ζ =	155°·44		ζ =	149°·32	$(M_2N)_4$	R =	236°·15
	H =	4·060		H =	·394		H =	·111		ζ =	·149
	κ =	329°·47		κ =	350°·90		κ =	257°·13		H =	278°·23
M_3	R =	·074	P_1	R =	·411	μ_2	R =	·219		κ =	·095
	ζ =	153°·08		ζ =	231°·82		ζ =	228°·41	$(M_2K_1)_3$	R =	279°·82
	H =	·078		H =	·411		H =	·234		ζ =	·089
	κ =	28°·95		κ =	40°·66		κ =	302°·91		H =	144°·99
M_4	R =	·103	J_1	R =	·117	R_2	R =	...		κ =	·070
	ζ =	260°·62		ζ =	223°·86		ζ =	...	$(2M_2K_1)_3$	R =	178°·57
	H =	·110		H =	·101		H =	...		ζ =	·068
	κ =	335°·11		κ =	82°·86		κ =	...		H =	65°·15

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·047	351°·33	·053	23°·75
„ Fortnightly „ . . .	·087	229·23	·061	25·17
Luni Solar „ „ . . .	·012	272 22	·012	234·97
Solar-Annual „ . . .	·081	45·97	·081	327·13
„ Semi-Annual „ . . .	·185	336·32	·185	178·64

VALUES OF THE TIDAL CONSTANTS, MINICOY, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Minicoy; and also the *mean* values of the amplitudes (H) and of the epochs (κ) or each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=5·247 feet.

S_1	H = R =	·037	M_6	R =	·001	Q_1	R =	·074	T_2	R =	·029
	κ = ζ =	203°·42		ζ =	328°·00		ζ =	236°·20		ζ =	290°·86
S_2	H = R =	·355		H =	·001		H =	·063		H =	·029
	κ = ζ =	19°·86		κ =	79°·78		κ =	54°·47		κ =	290°·81
S_4	H = R =	·004	M_8	R =	·002	L_2	R =	·024	$(MS)_4$	R =	·006
	κ = ζ =	99°·46		ζ =	308°·66		ζ =	129°·50		ζ =	29°·15
S_6	H = R =	·001		H =	·002		H =	·020		H =	·007
	κ = ζ =	228°·37		κ =	97°·71		κ =	6°·56		κ =	66°·41
S_8	H = R =	·000	O_1	R =	·394	N_2	R =	·163	$(2SM)_2$	R =	·005
	κ = ζ =	45°·00		ζ =	209°·19		ζ =	295°·15		ζ =	38°·66
				H =	·337		H =	·169		H =	·005
				κ =	59°·86		κ =	300°·01		κ =	1°·40

Short Period Tides—contd.

A_0=5·247 feet.

M_1	R=	·037	K_1	R=	·763	λ_2	R=	...	$2N_2$	R=	·024
	ζ=	236°·44		ζ=	222°·86		ζ=	...		ζ=	245°·36
	H=	·026		H=	·690		H=	...		H=	·025
	κ=	33°·53		κ=	50°·78		κ=	...		κ=	217°·80
M_2	R=	845	K_2	R=	·124	υ_2	R=	·013	$(M_2N)_4$	R=	·020
	ζ=	291°·03		ζ=	175°·38		ζ=	177°·25		ζ=	247°·98
	H=	·874		H=	·096		H=	·013		H=	0°·22
	κ=	328°·29		κ=	10°·83		κ=	285°·09		κ=	290°·09
M_3	R=	·007	P_1	R=	·212	μ_2	R=	·015	$(M_2K_1)_3$	R=	·010
	ζ=	302°·78		ζ=	239°·38		ζ=	173°·75		ζ=	222°·40
	H=	·008		H=	·212		H=	·016		H=	·009
	κ=	178°·68		κ=	48°·22		κ=	248°·27		κ=	87°·58
M_4	R=	·011	J_1	R=	·053	R_2	R=	...	$(2M_2K_1)_3$	R=	·003
	ζ=	332°·22		ζ=	223°·09		ζ=	...		ζ=	347°·74
	H=	·012		H=	·046		H=	...		H=	·002
	κ=	46°·74		κ=	82°·09		κ=	...		κ=	234°·34

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·050	7°·41	·057	39°·82
„ Fortnightly „	·059	231·44	·042	27·35
Luni-Solar „ „	·027	347·93	·028	310·67
Solar-Annual „	·399	63·84	·399	345·00
„ Semi-Annual „	·142	30·39	·142	232·71

Values of the Tidal Constants, Trincomalee, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Trincomalee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=1·987 feet.

S_1	H= R=	·014	M_6	R=	·005	Q_1	R=	·010	T_2	R=	·024
	κ= ζ=	71°·03		ζ=	350°·34		ζ=	33°·86		ζ=	205°·48
S_2	H= R=	·199		H=	·006		H=	·008		H=	·024
	κ= ζ=	265°·18		κ=	103°·79		κ=	212°·99		κ=	205°·45
S_4	H= R=	·008	M_8	R=	·002	L_2	R=	·032	$(MS)_4$	R=	·010
	κ= ζ=	173°·66		ζ=	111°·25		ζ=	331°·13		ζ=	301°·57
S_6	H= R=	·001		H=	·003		H=	·027		H=	·011
	κ= ζ=	198°·44		κ=	262°·52		κ=	208°·45		κ=	339°·39
S_8	H= R=	·001	O_1	R=	·081	N_2	R=	·139	$(2SM)_2$	R=	0·25
	κ= ζ=	159°·44		ζ=	99°·71		ζ=	209°·34		ζ=	253°·64
				H=	·069		H=	·144		H=	·026
				κ=	310°·96		κ=	215°·04		κ=	215°·82
M_1	R=	·016	K_1	R=	·233	λ_2	R=	...	$2N_2$	R=	011
	ζ=	81°·12		ζ=	140°·90		ζ=	...		ζ=	239°·93
	H=	·011		H=	·211		H=	...		H=	·012
	κ=	238°·49		κ=	328°·79		κ=	...		κ=	213°·52
M_2	R=	·566	K_2	R=	·046	υ_2	R=	·016	(M_2N_4)	R=	·025
	ζ=	204°·18		ζ=	37°·90		ζ=	267°·48		ζ=	104°·74
	H=	·585		H=	·036		H=	·017		H=	·026
	κ=	242°·00		κ=	233°·31		κ=	16°·13		κ=	148°·26
M_3	R=	·001	P_1	R=	·070	μ_2	R=	·029	$(M_2K_1)_3$	R=	·013
	ζ=	300°·96		ζ=	166°·94		ζ=	82°·51		ζ=	127°·14
	H=	·001		H=	·070		H=	·032		H=	·012
	κ=	177°·69		κ=	335°·86		κ=	158°·14		κ=	352°·85
M_4	R=	·009	J_1	R=	·009	R_2	R=	...	$(2M_2K_1)_3$	R=	·002
	ζ=	125°·54		ζ=	125°·61		ζ=	...		ζ=	284°·93
	H=	·010		H=	·008		H=	...		H=	·002
	κ=	201°·17		κ=	344°·29		κ=	...		κ=	172°·67

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·061	326°·58	·069	358°·69
„ Fortnightly „ . . .	·100	223·79	·071	19·10
Luni-Solar „ „ . . .	·019	2·71	·020	324·89
Solar-Annual „ . . .	·190	339·17	·190	260·31
„ Semi-Annual „ . . .	·256	306·87	·256	149·15

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations:—

Short Period Tides.

A_0=11·292 feet.

S_1	H = R =	·082	M_6	R =	·139	Q_1	R =	·047	T_2	R =	·138
	κ = ζ =	211°·22		ζ =	207°·59		ζ =	174°·52		ζ =	228°·92
S_2	H = R =	1·539		H =	·154		H =	·040		H =	·138
	κ = ζ =	97°·33		κ =	322°·48		κ =	354°·41		κ =	228°·91
S_4	H = R =	·105	M_8	R =	·064	L_2	R =	·226	$(MS)_4$	R =	·696
	κ = ζ =	112°·20		ζ =	242°·22		ζ =	184°·18		ζ =	39°·01
S_6	H = R =	·005		H =	·073		H =	·190		H =	·720
	κ = ζ =	39°·64		κ =	35°·40		κ =	61°·73		κ =	77°·30
S_8	H = R =	·003	O_1	R =	·232	N_2	R =	·650	$(2SM)_2$	R =	·069
	κ = ζ =	242°·65		ζ =	170°·27		ζ =	41°·27		ζ =	46°·44
				H =	·198		H =	·673		H =	·071
				κ =	22°·02		κ =	47°·71		κ =	8°·14
M_1	R =	·020	K_1	R =	·418	λ_2	R =	...	$2N_2$	R =	·142
	ζ =	80°·40		ζ =	224°·04		ζ =	...		ζ =	359°·72
	H =	·014		H =	·378		H =	...		H =	·147
	κ =	238°·00		κ =	51°·91		κ =	...		κ =	334°·30
M_2	R =	3·493	K_2	R =	·543	υ_2	R =	·176	$M_2N)_4$	R =	·081
	ζ =	18°·49		ζ =	251°·27		ζ =	244°·32		ζ =	322°·95
	H =	3·614		H =	·421		H =	·182		H =	·087
	κ =	56°·78		κ =	86°·64		κ =	353°·67		κ =	7°·69
M_3	R =	·040	P_1	R =	·147	μ_2	R =	·213	$(M_2K_1)_3$	R =	·093
	ζ =	119°·08		ζ =	231°·41		ζ =	112°·17		ζ =	171°·00
	H =	·042		H =	·147		H =	·228		H =	·087
	κ =	356°·53		κ =	40°·29		κ =	188°·76		κ =	37°·17
M_4	R =	·709	J_1	R =	·029	R_2	R =	...	$(2M_2K_1)_3$	R =	·060
	ζ =	319°·05		ζ =	269°·41		ζ =	...		ζ =	77°·92
	H =	·759		H =	·025		H =	...		H =	0·58
	κ =	35°·64		κ =	127°·81		κ =	...		κ =	326°·64

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·200	331°·46	·227	3°·31
„ Fortnightly „ . . .	·315	245 ·50	·222	40·30
Luni-Solar „ „ . . .	·902	76 ·62	·934	38·33
Solar-Annual „ . . .	3·326	233 ·44	3·326	154·56
„ Semi-Annual „ . . .	·593	131 ·91	·593	334·15

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ)

for each particular tide evaluated from the 1893 observations :—

Short Period Tides.

A_0=10·217 feet.

S_1	H =		M_6	R =	·196	Q_1	R =	·028	T_2	R =	·266
	R =	·103		ζ =	322°·45		ζ =	192°·95		ζ =	21°·71
	κ = ζ =	132°·92		H =	·217		H =	·024		H =	·266
S_2	H =			κ =	78°·94		κ =	13°·68		κ =	121°·72
	R =	2·215									
	κ = ζ =	168°·13	M_8	R =	·071	L_2	R =	·427	$(MS)_4$	R =	·381
S_4	H =			ζ =	283°·23		ζ =	249°·07		ζ =	168°·53
	R =	·082		H =	·081		H =	·360		H =	·395
	κ = ζ =	259°·43		κ =	78°·54		κ =	126°·87		κ =	207°·36
S_6	H =										
	R =	·013	O_1	R =	·342	N_2	R =	·985	$(2SM)_2$	R =	·179
	κ = ζ =	36°·06		ζ =	168°·71		ζ =	110°·25		ζ =	86°·41
S_8	H =			H =	·293		H =	1·020		H =	·185
	R =	·004		κ =	21°·02		κ =	117°·51		κ =	47°·58
	κ = ζ =	127°·75									
			K_1	R =	·747	λ_2	R =	...	$2N_2$	R =	·334
M_1	R =	·042		ζ =	203°·03		ζ =	...		ζ =	90°·19
	ζ =	299°·47		H =	·676		H =	...		H =	·346
	H =	·029		κ =	30°·89		κ =	...		κ =	65°·88
	κ =	97°·34									
			K_2	R =	·788	ν_2	R =	·272	$(M_2N)_4$	R =	·198
M_2	R =	5·851		ζ =	326°·59		ζ =	336°·46		ζ =	50°·67
	ζ =	90°·88		H =	·611		H =	·281		H =	·212
	H =	6·053		κ =	161°·92		κ =	86°·59		κ =	96°·76
	κ =	129°·71									
			P_1	R =	·200	μ_2	R =	·490	$(M_2K_1)_3$	R =	·085
M_3	R =	·017		ζ =	243°·82		ζ =	214°·89		ζ =	195°·73
	ζ =	201°·21		H =	·200		κ =	·524		κ =	·080
	H =	·018		κ =	52°·72		H =	292°·55		H =	62°·41
	κ =	79°·46									
			J_1	R =	·053	R_2	R =	...	$(2M_2K_1)_3$	R =	·142
M_4	R =	·38		ζ =	261°·29		ζ =	...		ζ =	161°·07
	ζ =	85°·38		H =	·046		H =	...		H =	·137
	H =	·414		κ =	119°·38		κ =	...		κ =	50°·87
	κ =	163°·04									

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·190	351°·64	·215	23°·21
„ Fortnightly „ . . .	·188	248·26	·133	42·48
Luni-Solar „ „ . . .	·464	82·94	·480	44·11
Solar-Annual „ . . .	1·423	224·85	1·423	145·94
„ Semi-Annual „ . . .	·187	139·85	·187	342·04

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893-94 observations at Mergui ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893-94 observations :—

Short Period Tides.

A_0=12·984 feet.

S_1	H =	·081	M_6	R =	·063	Q_1	R =	·034	T_2	R =	·356
	R =			ζ =	162°·33		ζ =	265°·81		ζ =	41°·41
	κ = ζ =	62°·07		H =	·070		H =	·029		H =	·356
S_2	H =	2·958		κ =	261°·33		κ =	290°·06		κ =	323°·56
	R =										
	κ = ζ =	349°·84									
S_4	H =	·039	M_8	R =	·011	L_2	R =	·288	$(MS)_4$	R =	·151
	R =			ζ =	55°·43		ζ =	250°·31		ζ =	267°·37
	κ = ζ =	235°·38		H =	·013		H =	·231		H =	·156
S_6	H =	·018		κ =	67°·43		κ =	319°·07		κ =	180°·37
	R =										
	κ = ζ =	100°·25									
S_8	H =	·002	O_1	R =	·252	N_2	R =	1·001	$(2SM)_2$	R =	·193
	R =			ζ =	306°·86		ζ =	16°·27		ζ =	42°·01
	κ = ζ =	243°·44		H =	·215		H =	1·037		H =	·200
				κ =	314°·73		κ =	305°·65		κ =	129°·01
M_1	R =	·032	K_1	R =	·591	λ_2	R =	...	$2N_2$	R =	·177
	ζ =	0°·55		ζ =	67°·87		ζ =	...		ζ =	299°·42
	H =	·025		H =	·534		H =	...		H =	·183
	κ =	289°·83		κ =	334°·14		κ =	...		κ =	245°·18
M_2	R =	5·290	K_2	R =	1·078	ν_2	R =	·324	$(M_2N)_4$	R =	·097
	ζ =	38°·90		ζ =	350°·82		ζ =	143°·25		ζ =	345°·51
	H =	5·479		H =	·831		H =	·335		H =	·104
	κ =	311°·90		κ =	343°·03		κ =	313°·62		κ =	187°·90
M_3	R =	·065	P_1	R =	·155	μ_2	R =	·423	$(M_2K_1)_3$	R =	·064
	ζ =	272°·62		ζ =	247°·05		ζ =	166°·51		ζ =	325°·47
	H =	·069		H =	·155		H =	·454		H =	·060
	κ =	142°·12		κ =	338°·09		κ =	352°·51		κ =	144°·74
M_4	R =	·107	J_1	R =	·041	R_2	R =	...	$(2M_2K_1)_3$	R =	·018
	ζ =	309°·47		ζ =	103°·43		ζ =	...		ζ =	175°·68
	H =	·115		H =	·035		H =	...		H =	·017
	κ =	135°·47		κ =	352°·18		κ =	...		κ =	95°·41

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·087	59°·65	·099	43°·27
„ Fortnightly „ . . .	·078	306·89	·055	24·16
Luni-Solar „ „ . . .	·078	310·46	·081	37·46
Solar-Annual „ . . .	·633	144·67	·633	143·63
„ Semi-Annual „ . . .	·135	123·58	·135	121·49

Values of the Tidal Constants, Port Blair, 1893.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1893 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1893 observations :—

Short Period Tides.

A_0=4·677 feet.

S_1	H =	·017	M_6	R =	·006	Q_1	R =	·025	T_2	R =	·078
	κ =	84°·77		ζ =	251°·90		ζ =	76°·41		ζ =	292°·60
S_2	H =	·953		H =	·007		H =	·021		H =	·078
	κ =	313°·66		κ =	7°·68		κ =	256°·78		κ =	292°·60
S_4	H =	·007	M_8	R =	·002	L_2	R =	·091	$(MS)_4$	R =	·019
	κ =	248°·05		ζ =	282°·53		ζ =	35°·98		ζ =	208°·02
S_6	H =	·000		H =	·003		H =	·076		H =	·019
	κ =	146°·31		κ =	76°·91		κ =	273°·66		κ =	246°·61
S_8	H =	·001	O_1	R =	·192	N_2	R =	·380	$(2SM)_2$	R =	·032
	κ =	338°·96		ζ =	90°·84		ζ =	266°·49		ζ =	190°·70
				H =	·165		H =	·393		H =	·033
				κ =	302°·90		κ =	273°·39		κ =	152°·10
M_1	R =	·021	K_1	R =	·442	λ_2	R =	...	$2N_2$	R =	·032
	ζ =	105°·72		ζ =	139°·41		ζ =	...		ζ =	268°·16
	H =	·015		H =	·400		H =	...		H =	·033
	κ =	263°·47		κ =	327°·27		κ =	...		κ =	243°·37
M_2	R =	1·924	K_2	R =	·327	ν_2	R =	·062	$(M_2N)_4$	R =	·045
	ζ =	240°·60		ζ =	108°·43		ζ =	117°·56		ζ =	210°·78
	H =	1·990		H =	·254		H =	·065		H =	·048
	κ =	279°·20		κ =	303°·78		κ =	227°·36		κ =	256°·28
M_3	R =	·007	P_1	R =	·136	μ_2	R =	·082	$(M_2K_1)_3$	R =	·017
	ζ =	135°·63		ζ =	157°·45		ζ =	210°·52		ζ =	194°·04
	H =	·007		H =	·136		H =	·088		H =	·016
	κ =	13°·52		κ =	326°·34		κ =	287°·71		κ =	60°·50
M_4	R =	·009	J_1	R =	·025	R_2	R =	...	$(2M_2K_1)_3$	R =	·006
	ζ =	97°·68		ζ =	142°·58		ζ =	...		ζ =	337°·31
	H =	·010		H =	·022		H =	...		H =	·006
	κ =	174°·87		κ =	0°·81		κ =	...		κ =	226°·63

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·043	318°·45	·049	350°·14
„ Fortnightly „	·082	228·25	·058	22·72
Luni-Solar „	·009	12·32	·009	333·72
Solar-Annual „	·216	241·06	·216	162·16
„ Semi-Annual „	·109	355·13	·109	197·34

Table showing the variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories, for each calendar year of the tidal operations.

Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.
	ADEN.	
1880	5·754	—·070
1881	5·828	+·004
1882	5·749	—·075
1883	5·788	—·036
1884	5·842	+·018
1885	5·878	+·054
1886	5·905	+·081
1887	5·813	—·011
1888	5·869	+·045
1889	5·831	+·007
1890	5·796	—·028
1891	5·835	+·011
1892	5·835	+·011
1893	5·806	—·018
Mean	5·824	
	KARACHI.	
1874	7·081	—·102
1875	7·167	—·016
1876	7·141	—·042
1877	7·192	+·009
1878	7·276	+·093
1879	7·316	+·133
1880	7·276	+·093
1881	7·183	·000
1882	7·091	—·092
1883	7·156	—·027
1884	7·189	+·006
1885	7·245	+·062
1886	7·221	+·038
1887	7·140	—·043
1888	7·132	—·051
1889	7·152	—·031
1890	7·166	—·017
1891	7·085	—·098
1892	7·244	+·061
1893	7·201	+·018
Mean	7·183	
	BHAVNAGAR.	
1889	22·703	+·045
1890	22·743	+·085
1891	22·592	—·066
1892	22·698	+·040
1893	22·555	—·103
Mean	22·658	
	BOMBAY. (Apollo Bandar.)	
1878	10·265	+·034
1879	10·185	—·046
1880	10·185	—·046
1881	10·252	+·021
1882	10·196	—·035
1883	10·254	+·023
1884	10·253	+·022
1885	10·306	+·075
1886	10·265	+·034
1887	10·205	—·026
1888	10·251	+·020
1889	10·205	—·026
1890	10·229	—·002
1891	10·156	—·075
1892	10·284	+·053
1893	10·211	—·020
Mean	10·231	

Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.
	MORMUGAO.	
1885	5·591	+·062
1886	5·553	+·024
1887	5·503	—·026
1888	5·468	—·061
Mean	5·529	
	KARWAR.	
1879	5·559	+·028
1880	5·525	—·006
1881	5·537	+·006
1882	5·501	—·030
Mean	5·531	
	BEYPORE.	
1879	5·411	+·012
1880	5·385	—·014
1881	5·389	—·010
1882	5·415	+·016
1883	5·397	—·002
Mean	5·399	
	COCHIN.	
1887	2·368	+·012
1888	2·319	—·037
1889	2·390	+·034
1890	2·356	·000
1891	2·347	—·009
Mean	2·356	
	TUTICORIN.	
1889	2·161	+·021
1890	2·155	+·015
1891	2·109	—·031
1892	2·135	—·005
Mean	2·140	
	GALLE.	
1885	2·711	+·062
1886	2·683	+·034
1887	2·616	—·033
1888	2·575	—·074
1889	2·661	+·012
Mean	2·649	
	COLOMBO.	
1885	2·266	+·049
1886	2·286	+·069
1887	2·221	+·004
1888	2·122	—·095
1889	2·189	—·028
Mean	2·217	

Table showing the variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories, for each calendar year of the tidal operations—contd.

Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.
	PAMBAN PASS.	
1879	2·678	—·036
1880	2·741	+·027
1881	2·722	+·008
Mean	2·714	
	NEGAPATAM.	
1882	1·972	—·054
1886	1·997	—·029
1887	2 110	+·084
Mean	2·026	
	MADRAS.	
1881	2·206	+·009
1882	2·198	+·001
1883	2·163	—·034
1884	2·172	—·025
1885	2·021	—·176
1886	2·327	+·130
1887	2·290	+·093
Mean	2·197	
	COCANADA.	
1887	5·314	+·054
1888	5·025	—·235
1889	5·328	+·068
1890	5·374	+·114
Mean	5·260	
	VIZAGAPATAM.	
1879	5·035	+·183
1880	4·940	+·088
1881	4·798	—·054
1882	4·829	—·023
1883	4·837	—·015
1884	4·670	—·182
Mean	4·852	
	FALSE POINT.	
1882	7·600	+·012
1883	7·605	+·017
1884	7·560	—·028
Mean	7·588	
	DUBLAT.	
1882	14·531	+·130
1883	14·426	+·025
1884	14·413	+·012
1885	14·233	—·168
Mean	14·401	

Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.
	DIAMOND HARBOUR.	
1882	9·369	+·332
1883	9·052	+·015
1884	8·920	—·117
1885	8·806	—·231
Mean	9·037	
	KIDDERPORE.	
1882	10·735	—·250
1883	10·587	—·398
1884	10·677	—·308
1885	10·935	—·050
1886	11·376	+·391
1887	11·180	+·195
1888	10·843	—·142
1889	11·180	+·195
1890	11·502	+·517
1891	10·633	—·352
1892	10·855	—·130
1893	11·321	+·336
Mean	10·985	
	CHITTAGONG.	
1887	7·969	—·039
1888	7·963	—·045
1889	7·975	—·033
1890	8·123	+·115
Mean	8·008	
	AKYAB.	
1888	7·436	—·077
1889	7·568	+·055
1890	7·662	+·149
1891	7·385	—·128
Mean	7·513	
	ELEPHANT POINT.	
1884	12·426	+·385
1885	11·747	—·294
1886	12·005	—·036
1887	11·984	—·057
Mean	12·041	
	RANGOON.	
1881	10·405	+·136
1882	10·438	+·169
1883	10·379	+·110
1884	10·185	—·084
1885	10·065	—·204
1886	10·368	+·099
1887	10·272	+·003
1883	10·157	—·112
1889	10·263	—·006
1890	10·450	+·181
1891	10·003	—·266
1892	10·273	+·004
1893	10·234	—·035
Mean	10·269	

Table showing the variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories, for each calendar year of the tidal operations—concld.

Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.	Calendar year.	Mean sea-level above zero of gauge in feet.	Yearly variation from general mean in feet.
	AMHERST.			**MERGUI.**	
1881 . .	13·740	+·088	1890 . .	13·050	+·060
1882 . .	13·788	+·136	1891 . .	12·895	—·095
1883 . .	13·792	+·140	1892 . .	13·036	+·046
1884 . .	13·668	+·016	1893 . .	12·980	—·010
1885 . .	13·271	—·381			
Mean	13·652		Mean	12·990	
	MOULMEIN.			**PORT BLAIR.**	
			1881 . .	4·673	+·003
			1882 . .	4·765	+·095
			1883 . .	4·743	+·073
			1884 . .	4·722	+·052
			1885 . .	4·676	+·006
			1886 . .	4·445	—·225
			1887 . .	4·724	+·054
			1888 . .	4·638	—·032
1881 . .	8·584	+·069	1889 . .	4·522	—·148
1882 . .	8·709	+·185	1890 . .	4·696	+·026
1883 . .	8·742	+·227	1891 . .	4·600	—·070
1884 . .	8·211	—·304	1892 . .	4·828	+·158
1885 . .	8·337	—·178	1893 . .	4·676	+·006
Mean	8·515		Mean	4·670	

With regard to the commencement made tentatively towards utilising the meteorological records of the tidal observatories for tidal purposes, I have as yet heard nothing on the subject from Mr. Roberts, and consequently the matter still remains in the postponed condition remarked upon in former reports.

The present state of the ordinary tidal computations is shown in the table given below, together with their state at the end of September 1893. The letters A. P. in the table indicate that the actual times and heights of high and low water have been measured from the tidal diagrams or graduated staves and compared with their predicted values published in the tide-tables. The actual amount of the usual work done during the year under report can thus be seen at a glance.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1893-94.

Tidal Observatory.	State at end of September 1893.	State at end of September 1894.
ADEN . . .	1890-91 calculations completed. 1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
MASKAT . . .		1893-94 calculations completed.
BUSHIRE . . .		1892-93 calculations completed.
KARACHI . . .	1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
BHÁVNAGAR . .	1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
BOMBAY (Apollo Bandar).	1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
BOMBAY (Prince's Dock).	1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
COCHIN . . .	A. P. 1892.	A. P. 1893.
MINICOY . . .	1892-93 calculations completed.	1893 calculations completed. A. P. 1893.
TUTICORIN . .	1892-93 calculations completed. A. P. 1892.	A. P. 1893.
COLOMBO . . .		A. P. 1893.
TRINCOMALEE . .	1891 calculations completed. 1892 calculations completed.	1893 calculations completed. A. P. 1893.
KIDDERPORE . .	1892-93 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
CHITTAGONG . .	A. P. 1892.	A. P. 1893.
AKYAB . . .	A. P. 1892.	A. P. 1893.
RANGOON . . .	1892 calculations completed. A. P. 1892.	1893 calculations completed. A. P. 1893.
MOULMEIN. . .	A. P. 1892.	A. P. 1893.
MERGUI . . .	1892-93 calculations completed. A. P. 1892.	1893-94 calculations completed. A. P. 1893.
PORT BLAIR . .	1892-93 calculations, commencing 30th January 1892, completed. A. P. 1892.	1893 calculations completed. A. P. 1893.

The extra tidal and levelling work is not entered in the table. This consisted—

(*a*) in reducing the tidal observations taken in 1883-84 at Aden with Professor G. H. Darwin's new apparatus for facilitating and abridging the reduction of tidal observations; comparing the results so obtained with those previously reduced in the ordinary way; and computing, by means of the new values, the constants for 1885 to enable predictions for that year at Aden to be run off on the tide-predicting machine: these predictions, together with those contained in the old tide-tables for 1885, are intended to be compared with the actuals, in order that, should the result prove satisfactory, the new method may be permanently adopted;

(*b*) in supplying the Engineer to the Corporation of Calcutta with a complete copy of the diagrams of the self-registering tide-gauge working at Kidderpore for the year 1893;

(*c*) in supplying the Officer in charge of the Marine Survey of India with the mean establishments of the port for 37 places, computed from observations during two semi-lunations at each place taken by the Marine Survey of India;

(*d*) in supplying the Executive Engineer, Special Defence Division, Military Works, Rangoon, with a copy of the times and heights of high and low water recorded by the self-registering tide-gauge at Brooking Street Wharf, Rangoon, during January, February, and March 1894;

(*e*) in supplying Messrs. Payne, Gilbert, and Sayani, Solicitors, Bombay, with copy of actual heights of the tide above Prince's Dock Sill, Bombay, at hourly intervals from noon of 31st July 1891 to noon of 4th August 1891 inclusive, measured by the self-registering tide-gauge at Prince's Dock tidal observatory;

(*f*) in supplying the Chairman, Port Commissioners, Rangoon, with inscriptions for the four plates of the Rangoon Standard Bench-Mark;

(*g*) in collecting and collating materials for a co-tidal chart, on Mercator's projection, of the tidal and levelling operations, and preparing the chart;

(*h*) in computing "the age of the tide" from one year's observations at each of the 36 Indian tidal stations;

(*i*) in tabulating for comparison, the monthly and yearly values of mean sea-level, at certain ports, and commencing the investigation of the question of the seasonal variation of sea-level;

(*j*) in computing the table of variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories for each calendar year of the tidal operations;

(*k*) in revising and doing other work connected with the Tidal volume;

(*l*) in submitting reports on the operations carried on in the Bombay Presidency and in Burma to the local Governments;

(*m*) in designing and rebuilding the tidal observatory at Bushire;

(*n*) in carrying out some extra spirit-levelling in and near Karachi, rendered necessary owing to the wholesale disappearance of the old bench-marks;

No completed tidal diagrams were sent for safe custody to the Surveyor-General's Office, during the year under report.

The Tide-Tables.

In addition to the calculations already mentioned, the usual work has been done in connection with the issue of the tide-tables for 1894 (which, on arrival at my office from London, were at once distributed), and with the preparation of those for 1895. The tide-tables were again issued late this year. They did not reach my office from London until the 2nd January 1894, whereas they ought to have been received before the end of November 1893, in order that they might be forwarded in time to the more remote stations. I have requested Mr. Roberts to print them at as early a date as possible, with the object of hastening their general issue; but, judging from past experience, his efforts in this direction must be neutralised, and a pecuniary loss to Government occasioned, so long as they are obliged to be passed through the Store Department of the India Office in London, whereby considerable delay occurs in their transmission. As an instance in point, I may mention that tide-tables for Rangoon for the present year, copied from the official tide-tables printed by Mr. Roberts in London, were sold in Rangoon by the *Rangoon Gazette* Press in December 1893, whereas the official tide-tables, supplied through the Store Department of the India Office, did not reach Rangoon until the following month. This circumstance appears to have greatly reduced the sale of the official tide-tables at Rangoon; for a comparison of their sales during this and the preceding year shows a sudden diminution of the proceeds amounting to 60 per cent. The action of the *Rangoon Gazette* Press, although thus inconvenient to Government, was probably convenient to the public, which had previously, as I mentioned in my last annual report, suffered from the delay involved by the present procedure for their transmission, whereby, for example, the tide-tables for 1890 did not reach Rangoon until February of that year. The Surveyor-General, as stated in the same report, expressed the opinion that a change

in the manner of issuing the tide-tables was desirable; and I think the time has come for making the change, and for authorising Mr. Roberts to dispense with the intervention of the Store Department, and to forward the tide-tables to my office direct, immediately after they are printed and bound. The supply could then easily reach my office early in each November; and, in order to protect the Government sale, copies ought either not to be procurable by the public in London or elsewhere before the same time, or all rights in the tables should be reserved to the Government or the official vendors.

In connection with the tide-tables for 1895, the values of the constants, calculated in the usual manner, were sent to Mr. Roberts ready for use in the Tide-Predictor; and in addition he was furnished with the actual values during 1893 of every high and low-water at eleven stations, measured in duplicate from the tidal diagrams, together with tidal observations for the same year taken daily during daylight from graduated staves or tide-poles at the sites of the Cochin, Tuticorin, Colombo, Chittagong, Akyab, and Moulmein tidal observatories, kindly supplied with great regularity by the Port Officials. In order to save Mr. Roberts the labour of the calculation, all the predicted times and heights of high and low water for 1893 at these stations were compared with the above-mentioned actual values and the errors tabulated, thus giving him in a convenient form, information capable of assisting him materially in improving the predictions. An improvement in the predictions for the riverain stations during the period of the south-west monsoon has always been a desideratum, but I am afraid that unvarying accuracy at that season of the year is unattainable, owing to the impossibility of making a true forecast of the rainfall, which has a great influence on the level of the river water. The riverain stations at which the accuracy of the observations has been tested are Kidderpore, Rangoon, Moulmein, and Chittagong. At Kidderpore, during the months preceding and following the south-west monsoon, the actuals accorded well with the predictions, the heights agreeing on the average within about 8 inches, and the times within about 15 minutes; but during the months of May, June, and July, although the times remained unaffected, the heights actually measured exceeded the predicted heights by over a foot on the average, and near the times of full moon the following extreme errors of height were observed:—

										feet.	inches.
On 26th	May	1893,	excess of	observed	H. W.	over	predicted	H. W.	=	7	2
„	„	„	„	„	L. W.	„	„	L. W.	=	4	1
„ 27th.	June	„	„	„	H. W.	„	„	H. W.	=	4	4
„	„	„	„	„	L. W.	„	„	L. W.	=	3	
„ 24th	„	„	„	„	L. W.	„	„	L. W.	=	3	7
„ 29th	„	„	„	„	H. W.	„	„	H. W.	=	3	11

The excess of the actual above the predicted heights of the tide at Kidderpore throughout the months of May, June, and July was largely due to the exceptional rainfall. The greatest excess of rain fell in May; the excess in June, although then declining, was still large; and much of the effect of the abnormal rain fall during these two months continued through the month of July. At Rangoon the actual and predicted tidal heights were accordant within a foot, except in June, July, October, and November, when the actual heights at low-water were about 16 inches less than the predictions, and the actual heights at high water were within ± 4 inches of the predictions. These errors call for special notice; for it is obviously dangerous for the actual heights of the tide, especially at low-water, to be materially less than the anticipated values. The time predictions at Rangoon were about 20 minutes late in January, February, and March, and about 15 minutes early in November, whilst for the other months of the year they were very close to the truth. Regarding Moulmein and Chittagong, nothing requires notice beyond what has already been mentioned in the paragraphs devoted to those stations.

The datum for the tide-tables for 1895 is the datum of soundings in the latest charts. A table giving the particulars of the datum at each tidal station was printed at page lii of the appendix to the General Report for 1891-92, and is applicable to the year 1895. The following particulars for Maskat and Bushire form an addition to that table:—

Tidal Station.	Datum of soundings in latest charts, and for tide-tables for 1895.
Maskat . . .	Mean low-water of ordinary spring-tides.
Bushire . . .	Ditto ditto ditto.

The tide-tables for 1895 will contain predictions for 35 tidal stations. The amount realised by the sale of the tide-tables is Rs. 340 less than was realised last year; and the limited number of presentation copies were distributed in strict accordance with the lists sanctioned by Government.

The usual tabular statements are appended, showing the percentage and amount of the errors in the predicted times and heights of high and low-water for the year 1893 at 17 stations, as determined by comparison of the predictions entered in the tide-tables for that year with the actual values, measured from the tidal diagrams at 11 stations

and from graduated staves or tide-poles at 6 stations; the former measurements being made by trained assistants in my office, and the latter by Port Officers' subordinates.

No. 1.

Statement showing the percentage and the amount of the errors in the Predicted Times of High Water at the various Tidal Stations for the year 1893.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	679	39	42	10	7	2
Karáchi	704	34	47	10	5	4
Bhávnagar	705	29	41	11	10	9
Bombay (Apollo Bandar)	705	36	44	11	7	2
Bombay (Prince's Dock)	694	30	43	14	11	2
Cochin	322	2	4	11	53	30
Tuticorin	349	43	43	8	5	1
Minicoy	692	35	38	13	10	4
Colombo	264	42	35	8	12	3
Trincomalée	690	15	25	8	14	38
Kidderpore	706	20	35	11	20	14
Chittagong	333	49	22	7	11	11
Akyáb	365	3	21	32	39	5
Rangoon	706	25	35	15	19	6
Moulmein	365	42	42	9	5	2
Mergui	705	35	40	7	10	8
Port Blair	705	40	47	8	3	2

No. 2.

Statement showing the percentage and the amount of the errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1893.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	673	38	40	10	8	4
Karachi	706	35	40	11	9	5
Bhávnagar	705	18	27	12	19	24
Bombay (Apollo Bandar)	704	33	45	8	10	4
Bombay (Prince's Dock)	695	35	40	12	10	3
Cochin	325	3	9	14	55	19
Tuticorin	347	38	40	11	7	4
Minicoy	696	33	41	11	10	5
Colombo	261	37	33	9	16	5
Trincomalée	685	14	21	8	17	40
Kidderpore	705	19	35	14	17	15
Chittagong	334	46	19	8	11	16
Akyab	366	1	17	31	36	15
Rangoon	704	26	33	10	16	15
Moulmein	365	32	35	9	13	11
Mergui	706	27	41	10	10	12
Port Blair	706	41	44	9	5	1

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1893.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	679	6·7	94	6	...	...
Karachi	704	9·3	74	22	4	...
Bhávnagar	705	31·4	35	27	18	20
Bombay { Apollo Bandar	705	13·9	68	27	4	1
Bombay { Prince's Dock	694	13·9	67	25	7	1
Cochin	322	3·2	93	7	...	...
Tuticorin	506	3·2	68	27	5	...
Minicoy	692	4·0	93	7	...	...
Colombo	264	2·6	90	10	...	...
Trincomalee	690	2·1	77	21	2	...
Kidderpore	706	11·7	33	21	15	31
Chittagong	333	13·3	29	20	22	29
Akyab	365	8·3	88	10	2	...
Rangoon	706	16·4	50	32	12	6
Moulmein	365	12·7	39	21	16	24
Mergui	705	18·1	70	22	6	2
Port Blair	705	6·6	94	6	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1893.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	673	6·7	96	4	...	...
Karachi	706	9·3	80	18	2	...
Bhávnagar	705	31·4	18	18	17	47
Bombay { Apollo Bandar	704	13·9	73	22	4	1
Bombay { Prince's Dock	695	13·9	68	25	6	1
Cochin	325	3·2	100	...	...	...
Tuticorin	505	3·2	81	17	2	...
Minicoy	696	4·0	91	9	...	...
Colombo	261	2·6	96	4	...	...
Trincomalee	685	2·1	70	27	3	...
Kidderpore	705	11·7	33	22	14	31
Chittagong	334	13·3	41	21	12	26
Akyab	366	8·3	63	32	4	1
Rangoon	704	16·4	18	27	22	33
Moulmein	365	12·7	31	24	15	30
Mergui	706	18·1	52	34	10	4
Port Blair	706	6·6	94	6	...	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1893.

Stations.	Mean range at springs in feet.	Average Errors.					
		Of time in minutes.		Of height in terms of the range.		Of height in inches.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Open Coast.							
Aden	6·7	10	10	·025	·025	2	2
Karachi	9·3	10	11	·027	·027	3	3
Bhâvnagar	31·4	13	20	·021	·032	8	12
Bombay { Apollo Bandar	13·9	10	11	·024	·018	4	3
Bombay { Prince's Dock	13·9	11	11	·024	·024	4	4
Cochin	3·2	27	24	·052	·026	2	1
Tuticorin	3·2	8	10	·010	·078	4	3
Minicoy	4·0	11	12	·042	·042	2	2
Colombo	2·6	10	11	·064	·064	2	2
Trincomalee	2·1	32	33	·119	·119	3	3
Akyab	8·3	19	23	·020	·040	2	4
Mergui	18·1	12	14	·018	·023	4	5
Port Blair	6·6	8	9	·025	·025	2	2
General Mean		14	15	·043	·042		
Riverain.							
Kidderpore	11·7	17	17	·071	·071	10	10
Chittagong	13·3	12	13	·063	·056	10	9
Rangoon	16·4	14	16	·025	·051	5	10
Moulmein	12·7	9	14	·052	·072	8	11
General Mean		13	15	·053	·063		

The foregoing statements for the year 1893 may be thus summarised :—

Percentage of time predictions within 15 minutes of actuals.

			High water per cent.	Low water per cent.
Open coast stations.	9 at which predictions were tested by	S. R. tide-gauge	73	68
	4 " " "	tide-pole	48	45
Riverain stations.	2 " " "	S. R. tide-gauge	57	57
	2 " " "	tide-pole	78	66

Percentage of height predictions within 8 inches of actuals.

			High water per cent.	Low water per cent.
Open coast stations.	9 at which predictions were tested by	S. R. tide-gauge	93	98
	4 " " "	tide-pole	98	98
Riverain stations.	2 " " "	S. R tide-gauge	68	50
	2 " " "	tide-pole	55	59

Percentage of height predictions agreeing within one-tenth of mean range at springs.

			High water per cent.	Low water per cent.
Open coast stations.	9 at which predictions were tested by	S. R. tide-gauge	96	95
	4 " " "	tide-pole	85	92
Riverain stations.	2 " " "	S. R. tide-gauge	89	84
	2 " " "	tide-pole	86	81

In this summary the tests are of two classes, the first and more accurate class being those made by means of self-registering tide-gauges, and the second being those made by means of tide-poles. I have mentioned, in the paragraph on Cochin, that while height readings (except in rough weather) can be accurately taken from a tide-pole, corresponding time readings, owing to the rough nature of the appliance and the chance of inaccuracy in the local time, must be allowed a considerable margin of error. Subject to this consideration, the predictions for time, although not equal to those for height, are undoubtedly very good; and the figures taken as a whole show a high standard of general accuracy.

BENCH-MARKS.

During the year under report one standard bench-mark for Calcutta has been under construction, and the following bench-marks and survey stations were connected in the course of the levelling operations :—

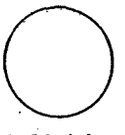
One bench-mark of reference for the town and cantonments of Karachi, 3 Harbour Works inscribed bench-marks at the same port, 38 ordinary embedded bench-marks, 330 ordinary inscribed or minor bench-marks, 13 railway bench-marks, 27 Irrigation and Public Works Department bench-marks, and 3 Great Trigonometrical Survey Stations. An extra number (32) of minor bench-marks on the alignment of the proposed railway from Sambalpur to Cuttack were also connected for the use of the Engineers who will construct the line of railway; and the particulars regarding them are on record in my office, but are not being included in the printed pamphlet of heights, as these bench-marks are all liable to disturbance.

The dimensions of the standard bench mark for Calcutta given in my last annual report have been slightly modified during its erection. It will be connected with the Kidderpore tidal observatory and the main levelling in Calcutta during the approaching cold season, and the inscriptions will be placed upon it, after which it will be fully described in the Government Gazette.

The bench-mark of reference for Karachi was erected in 1862, and all levels in Karachi are referred to it. It was accepted by Lieutenant-Colonel Laughton, S.C., of the Bombay Revenue Survey, as defining the datum of his survey of Karachi made in 1874-75. The original inscription gave the height to three places of decimals of a foot, and was as follows : "Height above mean sea-level 27·552 feet;" but this inscription became so weather-worn as to be almost illegible, and a solid slate, bearing the inscription given below, was fixed to the bench-mark during last season by Mr. Belcham, who tested the height and obtained for it a value of 27·559 feet, practically identical with its accepted value, which still remains in force. The bench-mark is solidly built on rock and is not liable to settlement. It is situated in the south corner of the compound of Holy Trinity Church, and consists of a circular masonry pillar 2 feet 2 inches in diameter, rising 2 feet 9 inches above ground level. It is plastered with Portland cement, and its top is capped by a thick horizontal slate. An iron pin 2 inches in diameter, fixed in the pillar, passes through a perforation at the centre of the slate and projects slightly above its surface; the top of the pin being the point of reference.

The slate is inscribed as follows :—

G. T. S.
Bench-Mark



Accepted height above
Mean sea-level 27·55
A. D. 1862.

The pillar is protected by a substantial iron railing, which was erected by the Irrigation Department.

On the 30th November last I sent Mr. Darlington, the Vice-Chairman, Port Commissioners, Rangoon, particulars of four inscriptions which were to be prepared on gun-metal plates and inserted in sunken spaces reserved for them on the standard bench-mark for Rangoon. After they have been placed in position, and the bench-mark has been finally inspected, a description of it will appear in the Government Gazette.

All the bench-marks of reference at the tidal stations were found undisturbed and in good order, with the exception of bench-mark A at Bushire, from which the inscribed stone had been purloined, but which was restored to its original condition by Mr. Belcham during last season. The bench-mark of reference of the Manora tidal observatory at Karachi was protected by a strong wooden railing during my inspection; and during my inspection of the Prince's Dock observatory, I had the letters G. T. S. B. M. chiselled as an addition to the bench-mark of reference.

All the bench-marks in Karachi and its suburb Manora laid down in 1859-60, namely, the first nine entered on page 38 of the Tables of Heights in Sind, the Punjab, North-Western Provinces, and Central India (Calcutta, 1863), have disappeared, with the exception of a bench-mark in Karachi Church (Holy Trinity Church), which was found by spirit-levelling in 1892 and 1894 to be gradually sinking, and which is quite useless. All the bench-marks laid down in 1883, when a line of levels was run from the tidal station at Manora to the last-mentioned bench-mark, have likewise disappeared. The heights of these bench-marks were not published.

Alterations having been made recently in the railway station enclosure at Chinchvad, within which embedded bench-mark No 104 (page 13 of Spirit-Levelled Heights Nos. 2 and 3, Bombay Presidency, etc.) is situated, the following are now the correct measurements from adjacent objects to the bench-mark, as furnished by the Agent, G. I. P. Railway Company :—"94 feet 8 inches west of the Government Telegraph Post $\frac{10^{0}}{18}$, 17 feet

south of the nearest rail, 77 feet 10 inches from the south-west corner of the station building, 62 feet 9 inches from the front return south-eastern corner of the platform palisade fence, and 91 feet 1 inch from back return corner of the same palisade fence.

Bench-mark No. 10 (page 7 of Spirit Levelled Heights, Burma) was reported by the Engineer-in-Chief, Burma State Railway, to have been unavoidably destroyed, owing to bridge No. 10 of the Sittang District, on which it was cut, having failed. He reported further that after the bridge had been rebuilt a circle was cut on the top of the south-east parapet wall, and the reduced level of the centre of the circle was found to be 15·23 feet above mean water-level at Rangoon.

Bench-mark No. 108 (page 22 of Spirit Levelled Heights, Burma) was also reported by the Engineer-in-Chief, Burma State Railway, to have been unavoidably destroyed, owing to bridge No. 132 of the Sittang District, on which it was cut, having to be rebuilt. He reported that a circle was cut on the top of the east parapet of the north abutment of the new bridge, and the reduced level of the centre of the circle was found to be 49·07 feet above mean water-level at Rangoon.

A bench-mark at the Poona Railway Station (No. 115, page 14 of Spirit Levelled Heights Nos. 2 and 3, Bombay Presidency, etc.) has been obliterated during alterations in the station platform.

I take this opportunity to suggest that it would be advantageous if the principal marks of reference, such as pillars of the base lines and standard bench-marks, and a proportion of the lesser though very important stations and bench-marks of the Great Trigonometrical Survey of India, were to be visited periodically and reported upon by an officer of the Department. At present the Department is without regular means of verifying the reports upon the survey stations, which are submitted by the Civil authorities as a matter of yearly routine from all quarters of India; and the destruction or dilapidation of stations and bench-marks is sometimes discovered only by accident. I mentioned in my last annual report how I chanced to be able to save from ruin the pillars of the Mergui Base Line; and in the appendix to the recently printed pamphlet of Spirit Levelled Heights, Burma, I reported that although the Trigonometrical Station at the Mergui Court House, through which the tidal station was connected with the line of levelling to the Base Line, had been carefully preserved, all the other bench-marks (seven in number) laid down in the town of Mergui in 1881-82 had disappeared. Part of the spirit-levelling I shall now proceed to report on was rendered necessary by the wholesale disappearance of the survey bench-marks at Karachi. I think that these instances of neglect, if not of mischief, at widely separated places, coming within the recent experience of a single officer, point to the desirability of carrying out the above suggestion.

Levelling Operations.

The extra levelling at Karachi, which was rendered necessary owing to the circumstances described above, was executed most satisfactorily by Mr. Belcham, and consisted of a line of the usual rigorous double levelling, carried from the tidal observatory at Manora to the Karachi Base Line, a distance of nearly 17 miles, in the course of which one important bench-mark of reference, 18 permanent minor or inscribed bench-marks, and one Great Trigonometrical Survey station were connected.

The regular levelling operations were carried out by Mr. J. Bond, and consisted of a continuous line of double-levelling from Sakti Railway Station of the Bengal-Nagpur Railway, where the work closed at the end of field season 1891-92, to Sambalpur, and thence across the Mahánadi and along or near the alignment of the proposed railway, on the south or right bank of the river, to Cuttack, closing at Kendrapára near False Point tidal station, and thus connecting Bombay by levelling with False Point and Calcutta. This line, together with 52½ miles of levelling executed by Mr. Bond in 1891-92, consists of the following two sections:—

(*a*) Biláspur to Sambalpur, 163 miles.
(*b*) Sambalpur to Kendrapára, 259 „

The levelling was carried during the past season over rough and hilly country covered with jungle and intersected with numerous streams and water-courses, falling into the Mahánadi, a difficult and unhealthy region, in which Mr. Bond and his detachment suffered much from illness. The total rises and falls amounted to 12,890 feet, and the outturn to 369½ miles of double-levelling, in the course of which the heights of 355 permanent bench-marks, 11 Railway bench-marks, 2 Public Works Department bench-marks, 25 Irrigation bench-marks, 2 stations of the Great Trigonometrical Survey, and 32 temporary bench-marks on the alignment of the proposed railway to Cuttack were determined. This is a good outturn and very creditable to Mr. Bond, who carried out his appointed work most efficiently and brought the direct line of spirit-levelling between Bombay and False Point to a successful completion, in spite of many difficulties. The highly satisfactory character of the levelling, thus completed, may be estimated by comparing the height of the closing bench-mark at Kendrapára as derived from the neighbouring tidal station of False Point with its height as derived from the origin of the line of levels at Kalyán Railway Station near Bombay.

The height derived from the origin is 1 foot 4 inches higher than that derived from False Point; and the distance between these points is 1,185 miles.

Extract from Report by MR. J. BOND, *Extra Assistant Superintendent, 4th grade, on the levelling operations executed—Season 1893-94.*

The levelling detachment, as under, proceeded by rail from Poona on the 20th November and commenced work at Sakti railway station on the 1st December 1893.

Levellers { Mr. J. Bond. Extra Assistant Superintendent.
Vinayek Narayan, Surveyor.

Recorders { Sub-Surveyor Balwant Atmaram.
„ V. V. Zanker.

A third, or auxiliary recorder, Govind Ramchandra, who was on leave, rejoined in the field on the 8th January.

The party had scarcely commenced work when malarious fever set in, and on the 8th December both levellers were completely prostrated and brought into camp by trolly, and the second leveller, Surveyor Vinayek Narayan, was ordered by the doctor at Raigarh to return to Poona.

The party then proceeded to Jhársuguda to recruit their health, pending the arrival of Sub-Surveyor Sitaram Yeshwant, who was sent to take the place of Surveyor Vinayek Narayan as second leveller. He arrived at Jhársuguda on the 16th December, but as he had no acquaintance whatever wtih spirit-levelling observations, a few days were devoted to instructing and practising all the sub-surveyors, *viz.*, Sitaram Yeshwant, Balwant Atmaram, and V. V. Zanker, in the use of the standard levels and staves, as there was a likelihood of further casualties from sickness, and I was so frequently ill myself that I scarcely expected to be able to get through the season's work.

Work was resumed on the 22nd December with Sub-Surveyor Sitaram Yeshwant as second leveller, but after working with the party seven weeks and completing 116 miles, he also fell sick and was sent home to Poona, as the Civil Surgeon stated he would be unfit to resume field work. Sub-Surveyor Balwant Atmaram then took his place, and worked from the 12th February to the end of the season as second leveller.

The Mukadam of the detachment, Rama Tekaora, reported his return to duty at the end of the recess; but before the field operations commenced, he died of influenza on the 12th November 1893. His death was a great loss to the detachment. The experience he had in selecting stations in advance over broken, undulating and hilly country, and across streams was of great value, and accelerated the work.

The percentage of sick was so great at times that I found the greatest difficulty in moving camp. Carts were engaged at Sambalpur by the month for the carriage of the camp equipment, and beyond that place none were obtainable even for the carriage of the sick. I had, therefore, to send everything that could be spared for a fortnight or so, about 50 miles in advance, and the carts on their return were used for the carriage of the sick, and as opportunity occurred those men who were unfit for further work during the field season were sent to their homes.

Throughout the field season every one in camp suffered more or less from sickness, and the progress of the work was consequently very much retarded. The past field season was from beginning to end the unhealthiest I have ever experienced.

Results of comparison of staves—Season 1893-94.

Date of comparison.	Mean difference of length of pairs of staves from 10 feet.	
	Staves B1 and B2,	Staves B3 and B4.
Raigarh, 25th November 1893	+·000716	+·001547
Sambalpur, 23rd January 1894	—·000567	—·000880
Harbhanga, 24th March 1894	—·001353	—·002424
Kendrapára, 25th May 1894	—·000812	+·000058

I append the usual tabular statement of the outturn of levelling, also the followin tables :—

Table A, giving the Great Trigonometrical Survey stations connected, and the errors of their original heights.

Table B, railway bench-marks connected on the Bengal-Nagpur Line, and their errors.

Table C, irrigation bench-marks connected, and their errors.

Tabular Statement of outturn of work for the field season 1893-94 from Sakti Station of the Bengal-Nágpur Railway, via Sambalpur and Cuttack, to Kendrapára.

During the month of	Number of miles, Double Levelling.		Total number of feet.		Number of stations at which the instrument was set up.	Number of bench-marks connected.						
	Main Line.	Branch Line.	Rises.	Falls.		Reference.	Embedded.	Inscribed.	G. T. Survey stations.	Railway.	Public Works Department.	Irrigation.
	M. C. L.	M. C. L.										
December 1893 .	57 78 64	0 42 92	753·887	600·930	440	...	5	62	...	5	...	...
January 1894 .	57 18 10	6 8 0	1063·791	1563·523	602	...	8	60	1	2	...	1
February „ .	48 66 14	0 41 0	927·441	903·189	503	...	5	8	...	...	...	...
March „ .	72 73 17	...	1724·291	1787·084	881	...	8	63	...	2	1	...
April „ .	65 23 80	...	1228·277	1279·245	780	...	6	71	...	2	...	...
May „ .	58 14 40	1 76 0	533·693	524·852	561	...	6	53	1	...	1	24
TOTALS .	360 34 25	9 7 92	6231·380	6658·823	3,767		38	317	2	11	2	25
Extra levelling at Karachi . .	16 12 50	0 40 0	174·022	136·805	144	1	...	16	1	2	...	...
GRAND TOTALS	376 46 75	9 47 92	6405·402	6795·628	3,911	1	38	333	3	13	2	25

Table A.

List of Great Trigonometrical Survey Principal and Secondary stations connected by spirit-levelling—Season 1893-94.

Series.	Name of station.	Height in feet above Mean Sea Level.		Error of height by Triangulation in feet.	Remarks.
		By spirit-levelling.	By Triangulation.		
Sambalpur Secondary .	Lohár, H. S. . .	1268	1271	+3	On circle and dot mark on rock *in situ*.
East Coast Principal .	Cuttack, H. S. . .	134	132	−2	The height refers to the mark stone at the top of the pillar.
			By levelling in 1859-60.	Amount of settlement in feet.	
Great Indus Principal .	S. End, Karachi Base .	46·29	46·38	0·09	A dot on silver at floor level defines the station.

Table B.

List of Railway Bench-marks on the Bengal-Nagpur Railway connected by the Survey of India Levelling Operations—Season 1893-94.

No.	Bench-marks.	Height above Mean Sea level in feet.		Error of Railway Levels in feet.
		By Survey of India Levelling Operations.	By Railway Levels.	
68	Rail at Kharsia Railway Station	844·47	840	−4
83	„ Náharpali „	784·40	780	−4
99	„ Raigarh „	703·79	700	−4
115	„ Jámga „	752·84	749·5	−3
127	„ Kanika „	888·13	885	−3
138	„ Belpahár „	761·73	759	−3
151	„ Jhársuguda „	756·53	753	−4

Note.—Both Survey of India and Railway levels originated in Bombay.

Table C.

Comparisons of P. W. D. Irrigation Bench-marks connected by spirit levelling—Season 1893-94.

No.	Bench-marks.	Height in feet above Mean Sea level at False Point.		Error of P. W. D. Levels in feet.
		By Survey of India Levelling Operations.	By D. P. W. Levels.	
180	□ 103·59 ⩚ At Ramchandi Devi's Temple, on the right bank of the Mahánadi, ¼ mile east of mile post No 16 on the road from Cuttack to Sambalpur	102·85	103·59	+0·74
209	Mahánadi River Gauge at Cuttack (69 foot 8-inch graduation)	69·08	69·67	+0·59
210	B. ⩚ M. □ 76 54 Kendrapára Canal Head Lock at Jagatpur .	75·76	76·54	+0·78
228	G T. S. B. M. ○ 45·30 Kendrapára Canal Bench-mark about ¼ mile west of canal milestone No. 15 from Jagatpur. The letters G. T. S. B. M. were added during last field season	45·25	45·30	+0·05

I shall now add some remarks on the standard of accuracy of the Survey of India spirit-levelling operations. The rigorous procedure employed in these operations is described in Colonel Walker's "Memoranda on Levelling Operations" published in the Appendix to the Manual of Surveying for India, 3rd Edition (Thacker, Spink & Co., Calcutta, 1875), and in the introductions to the several departmental pamphlets of spirit-levelled heights. The general system, which is gradually approaching completion, consists at present of lines of double levelling extending from tidal station to tidal station, either by more or less direct routes near the coasts, or by crossing the Peninsula from sea to sea at different latitudes, the lines sometimes interlacing and forming circuits. The lines have been planned to form junctions with the great triangulation, the heights of which they control, and to follow as much as possible the great lines of communication along railroads, high roads, rivers and canals. Standards of accuracy, such as are familiar elsewhere, by which the error of levelling is restricted within such limits as 1 inch per mile, 2 feet or 1 foot per 100 miles, etc., would be useless; for it is seldom that the resulting heights can be checked before the levelling has proceeded for many hundreds of miles. This renders the most rigorous precision imperative; and a very small amount of disagreement is consequently permitted between the readings of the two levellers, who work in concert and with different instruments.

The following table shows the maximum and terminal differences between the heights obtained by the two levellers along six sections of the line of levelling from Karachi, *viâ* Calcutta, to False Point:—

Section of line.	Length of Section.	Maximum difference between the results obtained by the two levels.	Terminal difference between the results obtained by the two levels.
	miles.	feet.	feet.
Márú Pir, Upper Sind, to Dera Ghazi Khan .	310	0·98	0·98
Márú Pir, Upper Sind, to Karachi . .	301	1·39	·94
Dera Ghazi Khan to Chach near Attock .	360	·35	·01
Calcutta to Tiliagarhi	242	·20	·15
Tiliagarhi to Patká Gerouli	346	·40	·38
Agra to Patká Gerouli	343	·15	·06
Mean maximum difference per 100 miles .		0·18	...

The very high standard of accuracy preserved in the Survey of India spirit-levelling operations may be realised by inspecting the following Tables I and II. Table I gives eight typical specimens of lines of levelling connecting tidal stations, and the errors shown in it were calculated on the assumption that the height of mean sea-level is the same at all the tidal stations. Table II gives five specimens of closed circuits taken at random from the published pamphlets of spirit-levelled heights. In calculating the errors in both tables signs were disregarded, so that errors of contrary signs did not tend to neutralise each other:—

Table I.

	Line of levelling from mean sea-level to mean sea-level at the undermentioned tidal stations.	Length of line of levelling.	Apparent terminal difference, using latest values of mean sea-level.	Resulting error per 100 miles.
		miles.	feet.	feet.
From Arabian Sea to Bay of Bengal.	Karachi to False Point *viâ* Calcutta . .	2,500	+1·72	0·07
	Bombay to False Point direct	1,218	+1·60	·13
	Kárwár to Madras	560	+ ·97	·17
	Beypore to Madras	409	+ ·64	·16
West Coast of India.	Okha to Bombay	580	+ ·42	·07
	Bombay to Kárwár	530	+ ·74	·14
East Coast of India.	Madras to Negapatam	269	− ·52	·19
	Madras to Cocanada	391	− ·39	·10

Table II.

Closed Circuit.	Length of circuit.	Closing error.	Error per 100 miles.
	miles.	feet.	feet.
Cawnpore-Meerut-Moradabad-Bareilly-Lucknow-Cawnpore .	620	·64	·10
Dildárnagar-Gorakhpur-Lucknow-Cawnpore-Dildárnagar . .	602	·05	·01
Pírpaintí-Dildárnagar-Gorakhpur-Purneah-Pírpaintí . . .	815	·78	·10
Kedgaon-Gulbarga-Ráichur-Gooty-Bellary-Hubli-Kedgaon .	844	1·13	·13
Ráichur-Gooty-Bellary-Ráichur	236	·16	·07

The Survey of India does not profess to keep the errors of heights obtained by spirit-levelling within any fixed limit; but prefers turning out the very best work possible and discovering afterwards what its errors may amount to. Spirit-levelling of which the error does not exceed 1 foot per 100 miles is generally considered to be practically perfect. It will be found that the mean error of the great spirit-levelling operations dealt with in Tables I and II is about 1 foot per 1,000 miles.

During next field season the levelling operations will be continued from where they terminated last season near Cuttack and extended down the Coast to join the line that was brought northward as far as Vizagapatam in 1888; connecting trigonometrical stations of the East Coast Series and completing the junction by spirit-levelling of all the tidal stations along the Eastern Coast of India. The standard bench-mark for Calcutta will also be connected with the Kidderpore tidal observatory and with the spirit-levelling already executed.

Several years will be required in order to complete the general scheme of spirit-levelling operations. The completed system should consist of a central trunk, continuous from south to north, with branches extending from it at various latitudes to the tidal stations on either sea, and supplemented by extra levelling where necessary. The portion of the system lying south of a line joining Bombay and Cocanada may be considered as finished, but much remains to be done to the north of that line. Thus, for example, the central trunk requires completion between Bider and Bhopal; a branch is required to join Allahabad and Biláspur, and to be continued thence to the tidal station at Vizagapatam; and several other lines of levelling are required in Rajputana, Bengal and Burma, which can be undertaken when those I have mentioned shall have been completed.

CHIN-MANIPUR BOUNDARY DELIMITATION.

Extract from the Narrative Report of CAPTAIN F. B. LONGE, R.E., *in charge No. 21 Party, on the operations with the* CHIN-MANIPUR BOUNDARY COMMISSION—*Season 1893-94.*

On my return to Burma in January 1893 I received orders to arrange either to accompany the Chin-Manipur Boundary Commission which was to have proceeded within a few weeks to lay down a definite boundary between the two hill tracts, or to depute one of my assistants to carry out the survey work with it; but owing to a rising in the Chin Hills the work had to be postponed until the spring of 1894.

This was perhaps not altogether unfortunate, as the Political officers in the Chin Hills and Manipur differed considerably, and in some important points, as to the general line the boundary should take, and it was not till late in 1893 that the Government of India decided that a frontier line should be selected following natural features and approximately in the latitude of the line shewn by Pemberton as the southern limit of Manipur in 1833-34, but excluding the village of Lenacot from Manipur.

I do not propose to go deeply into the history of the Manipur boundary, which has been more or less fully described by Mr. Carey in his report, but a short statement of the case may be of some interest, the facts being derived from notes and reports by that officer.

At the outbreak of the first Burma war the Burmese were in possession of Manipur and had overrun Cachar, but the British arms now ousted them and enabled the Manipuris to conquer the Kabaw (Kubo) Valley, which had for the previous twelve years been in the possession of Burma. In the treaty of Yandaboo in 1826 no mention was made of the Kabaw (Kubo) Valley, nor was any boundary laid down between Burma and Manipur, and from 1826 to 1833 the question was constantly before the Governments of India and Burma. It was finally decided in the latter year that the Kabaw Valley should be handed over to Burma, and in November of that year Major Grant and Captain Pemberton were deputed to do so, pointing out *its* northern and southern limits and the *eastern* boundary of Manipur.

This was done, but Pemberton also proceeded to define a southern limit to Manipur by continuing the southern line of the Kabaw Valley westward to the Manipur river. The

line thus drawn ran through territory inhabited by Chins, who were independent of both Manipur and Burma, and it does not appear to have been recognised by them in any way, for they raided indiscriminately in all directions, into Lushai, Manipur and Burma. Frequent expeditions were sent against them from Manipur and also from Burma and Lushai, but all failed to overawe the Chins, who continued their aggressions until, having conquered Upper Burma, it became necessary for us to occupy the hills sheltering this warlike and savage race, in order to protect our people and property in the plains and valleys. The hills were consequently occupied and administered in 1888.

Gradually it became necessary to extend northwards, and consequently the question of the southern limit of the Manipur State arose, and as no boundary had ever been demarcated, nor was any such line recognised by the hill tribes, the recent Boundary Commission was ordered to settle the question finally.

The Commission was appointed to assemble at Tinzin in the Kabaw Valley on the 27th January 1894. I only received intimation of the date finally fixed while at Thamakan in the Southern Shan States on the 4th January, and as it was absolutely necessary for me to spend a few days at Mandalay to arrange for the future work of No 21 Party, etc., I had to hurry there at once, leaving Captain Gordon in charge of the party, and managed by going across the hills direct from Kindat to reach Tinzin on the date fixed. Mr. Carey, C.I.E., Political Agent, Chin Hills, had reached that place on the 25th, and the Manipur portion of the Commission under Mr. Porteous, I.C.S. arrived at the same moment as myself.

The strength of the Burma party was as follows :—

Commissioner, B.S. Carey, Esq., C.I.E.
Survey of India, Captain F. B. Longe, R.E., Mahomed Latif, Surveyor, and 11 followers.
Intelligence, Lieut. W. H. Dent, Yorkshire Regiment, and two havildars.
Escort, Lieutenant B. Trydell, Commanding, 2 Native officers and 51 rank and file, 1st Burma Rifles.

The Manipur party comprised :—

Commissioner, A. Porteous, Esq., C.S.
Escort, Captain M. Kerr, Commanding, Lieutenant Baillie, 2 Native officers and 100 rank and file, 43rd G. L. I.

Messrs. Carey, Porteous and I spent the afternoon of 27th January discussing the general run of the boundary, and it was then practically decided to accept the Tui Sa river or Tinzin Chaung for the boundary to start with, as by so doing it did not deprive Hauchinkup, the Kanhow Chief, who was with us, of two of his villages, namely, Haulkam and Hernzan, which are situated in the hills south of the Tui Sa. Had the Tui Pu or Nampalaw Chaung been adopted, these villages would have passed to Manipur.

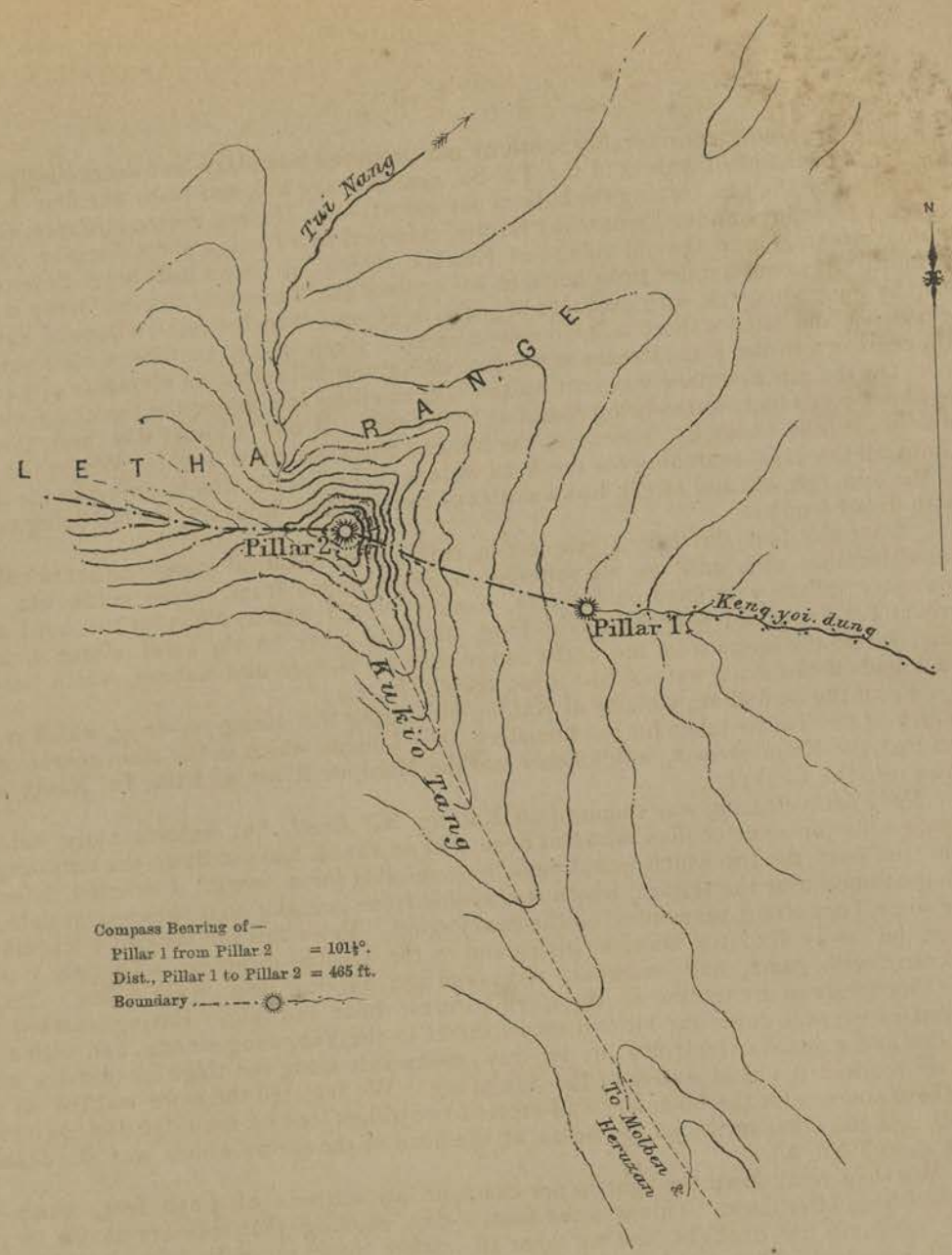
On the 28th January we went up a small hill, height about 1,500 feet above sea-level, and 3½ miles west of Tinzin, whence we had a good view of the course of the Tui Sa : we decided to move camp to Hernzan and thence ascend Molben hill, and there decide whether we should adhere to the river or run the boundary up the ridge to the top of the Letha Range (Tang). Accordingly we marched on the morning of the 29th across the hills to the Tui Sa stream. The site of the camp is 7 miles from Tinzin and called Bong Pai, its approximate elevation being 940 feet. The highest point on the road is, by barometer, 2,100 feet. Our transport coolies were wretched specimens and did not all manage to bring in their loads; consequently we were obliged to halt the next day. Mahomed Latif, whom I had sent by the river with an escort and guides, did not reach camp until noon next day, and altogether our start was unfortunate.

However, being reinforced by some Chin coolies from Haulkam, we marched on the 31st January at 7 A.M. and reached that village, a wretched place of 8 houses, at 10 A.M. The Manipur party had gone on the day before and had cleared a knoll above the village and erected a scaffolding for me, whence a very fair view was obtained. Height by boiling point, 2,094 feet. We halted here a short time and then moved on about 4½ miles to an old village site called Pangchin (3,207 ft.), where we found sufficient water for drinking purposes and halted for the night.

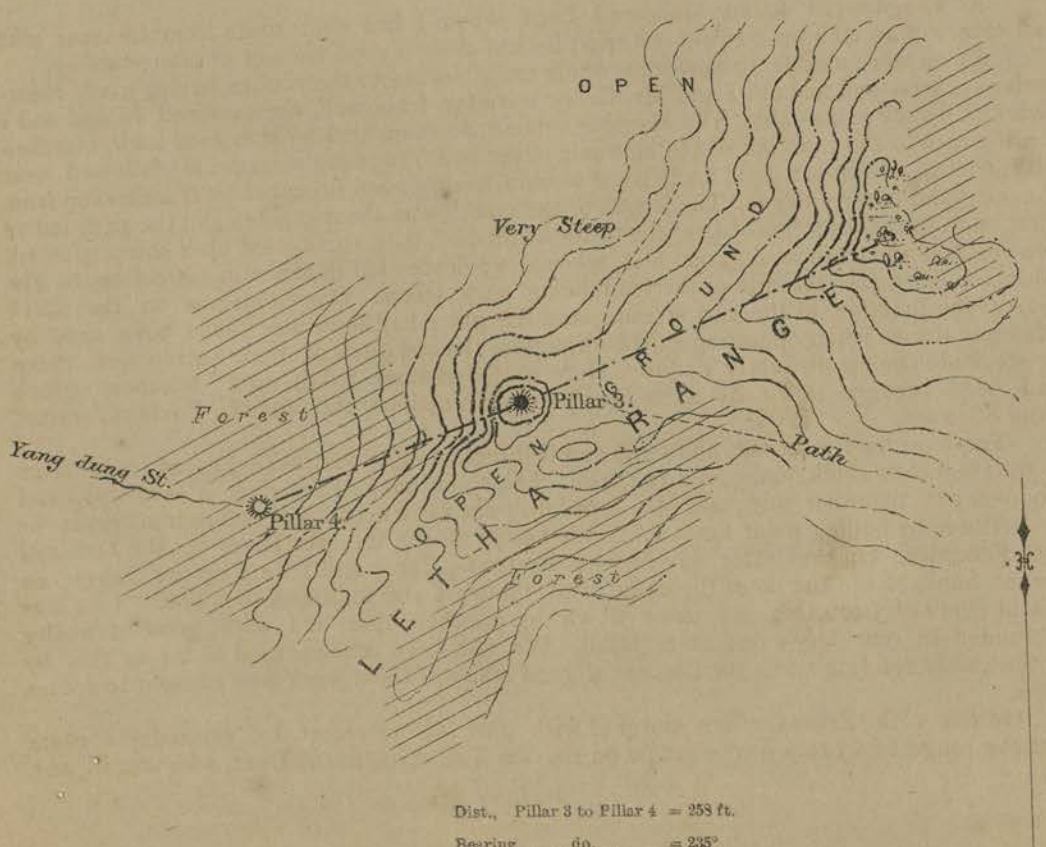
On the 1st February we reached Hernzan, height 4,186 feet, and distant 8 miles from Pangchin. This is a village of about 70 houses on a spur from Molben. It was very foggy and cloudy, and I could do very little work. Mr. Porteous, who had gone on the day before, ascended Molben and commenced clearing. On the 2nd February I went up the hill with Messrs. Carey and Porteous and continued clearing, but we were all day in clouds and could see nothing. On the 3rd I again went up Molben and observed from it. We decided to continue the boundary up the Tui Sa in preference to a spur to Molben. On the 4th February we marched about 7½ miles to a small lake under the top of the Letha Range at an elevation of about 5,670 feet called Tui Pi : this place is seldom visited by the Chins who consider it "uncanny." Starting from Hernzan we descended by a very steep path to the Tui Pu, which we crossed at an elevation of 2,147 feet; thence we ascended by a long steep spur to within a mile of our camp on the lake, which is about 100 yards by 50 yards in dimensions. The view to the south was fairly open, but the northern slope was densely wooded and I could see very little in that direction.

On the 5th February we reached Shielmong (Lenacot), a dirty village of 65 houses at an elevation of about 4,800 feet. The highest point on the road is 6,500 feet where we crossed the Letha Range. It was very cloudy, the hill tops being invisible.

Sketch 1.



Sketch 2.



Reg. No. 643. S. I. D.—Dec. 94.—450.

Litho., S. I. O., Calcutta.

No. 416-S. 94.

We were now considerably south of our proposed boundary and accordingly decided to march to the head waters of the Tui Sa, near Katong hill, and plant our first boundary pillar; so on the 6th, leaving the bulk of our escort, etc., Messrs. Porteous, Carey, Dent and I, with 40 sepoys under Lieutenant Baillie, marched to a camp a short distance off on the Kana stream, below the old village of Kunum, which we found had been deserted and rebuilt. At about 4 miles from Lenacot we crossed the Yangdung stream, when we were met by some villagers, with presents of goats, eggs, etc., from the small village of Yangdung close by, and after a short talk we moved on up a steep spur to the site of old Kunum and thence down to the Kana stream at the foot of Katong hill and at an elevation of 3,400 feet.

On the 7th February we went up the hill, camping just under the top at an elevation of about 7,350 feet, water being found at that point. It was a lovely day and the camp was beautifully situated. I went up the hill and observed a few angles. We halted at this camp till the 11th, searching for the head waters of the Tui Sa, which, owing to the density of the undergrowth and forest, was a matter of considerable difficulty, the hill being covered with dwarf bamboo.

After the first day half a gale set in, making our beautiful camp rather a cold and uncomfortable one, and we all suffered in consequence from severe colds, etc. Two boundary pillars were fixed on the 10th, namely, Nos. 1 and 2; No. 1 at the head of the stream Tui Sa, called here Keng-yoi-dung, and the other on the knoll above it, at the point where the spurs from the Letha range start to Molben and Katong, which latter hill we found off the main watershed. (See sketch No. 1.)

From the immediate vicinity of Katong hill spring the Keng-yoi-dung, which is that branch of the Tui Sa taken for the boundary; the Lailem, which is the main source of the Tui Pu; the Kana stream, which flows into the Manipur River, and the Tui Nang, which flows into the Chakpi.

Very little clearing was required on Katong hill itself, but unfortunately before I reached the top some coolies, who had been sent on ahead, had cut down the only respectable tree near the top which would have been suitable for a mark. I erected, however, a big bamboo over the station, which was visible from Lentang on a subsequent date, but has since, I am afraid, succumbed to the heavy wind. From this hill we had a magnificent view, far away into the Manipur plains and in the Lushai direction. The whole place swarmed with game, and sambhur, red *sarao* and barking deer were killed. Besides this there were many tracks of tiger, rhinoceros, bear and pig. Having marked the boundary we sent down our kit and escort direct to the Yangdung stream, and with a few coolies and a guard of ten rifles cut our way westwards along the ridge for about 2 miles till we reached the head waters of the Yangdung. We selected the more marked of the northern sources for the boundary and erected two pillars, one on the ridge itself on a clear knoll, and the other in the jungle below at the head of the ravine which was ill defined. (See sketch No. 2.)

We then went down the spur to our camp, at an altitude of 3,050 feet, which we reached long after dark. This was the fourth day running that we were unable to get back to camp by daylight, and we were all rather done up with fatigue and exposure, for we had no tents and the wind had been bitterly cold: the drop from the boundary pillar to camp was nearly 5,000 feet in less than 5 miles and we tumbled about a good deal as we scrambled down.

At Yangdung, I found Mahomed Latif whom I had sent south from Lenacot with an escort of 20 men on a two-days' trip; he had done a good amount of plane-tabling.

As we were unable to move the whole camp, owing to the coolies having made themselves scarce, and as both I and Mr. Carey were far from well, we remained behind and I worked up my plane-table. The Manipur column, accompanied by Mahomed Latif, marched on the 12th to the junction of the Manipur River and Yangdung stream; we followed next day, coolies, of whom a good many were women, having been procured by Hanchinkup from Lenacot and other villages. The length of the march was about 9 miles and the path led us first back in the direction of Lenacot to the watershed, then north-west up a steep spur, till we reached an altitude of 5,000 feet, whence we descended in the same direction, to the Manipur river, the last mile of the road being very steep. Our camp was on the north side of the junction of the two streams, and the place had in former times been used by Manipur armies when operating in this direction, the old ditch of their entrenched camp or stockade being distinctly visible. Here we found some "dug outs" (canoes) which had been brought down by some Manipuris with rations, etc., for Mr. Porteous' escort from Shuganu.

The river here is broad and swift and is intersected by vertical dykes of rock from 6 to 18 inches thick, embedded in shale. The right bank of the river is very steep and wooded, but the other side was just here fairly flat for a breadth of a hundred yards or so: altitude by boiling point 2,253 feet. We halted on the Manipur River on the 14th and 15th February. On the latter day Messrs. Porteous, Carey and I went up the range on the far bank, to see the lie of the country to the west and to decide our line. This was a stiff climb of 3,400 feet; we came down by another spur and with great difficulty succeeded in reaching camp at nightfall. We had been accompanied as far as this by all the chiefs residing along the border: a good many of them were now allowed to return home.

On the 16th February we marched with part of our escort by yesterday's route over the range to a camp in the jungle on the Tui Ta. Lieutenant Dent, who was ill, and

Lieutenant Baillie remained at the river with half the escort. We fixed No. 5 pillar at the head waters of the Yangkai and Tui Ta streams (see sketch No. 3) and reached camp at dark. On the 17th February I proceeded along the ridge to the north surveying and later in the day joined Messrs. Porteous and Carey who had gone westwards. We were unable to move camp as the Burma portion of the Commission was still at the Manipur River. They came in during the day and on the 18th we moved camp over the ridge (height 5,250 feet), lower down the stream about 3½ miles to the foot of the Lentang range, and at noon Messrs. Carey, Porteous and I went to the top of the range and decided our next move. We cleared the hill at the source of the stream on which we were camped and which we decided should be the boundary, and from it obtained a fine view of the Lung Leng, Lung Tul and other ranges, as well as of Kailam and Howbi. We could also see the villages of Tanvum and Sunkum, etc., to our north and north-west. The height of our camp on the Tui Ta was 3,800 feet.

On the 19th February we marched to a camp in a deep ravine in dense jungle immediately below a magnificent cliff called Khovet, which towered 2,000 feet above us. On this hill was formerly a village called Manbum which was inhabited by Chaksad Kukis, called Taksat by the Chins; they were attacked and defeated by the Pois (Yahaws and outlying Tashons) and compelled to fly, and have settled in the west of Thaungdut Nali.

A very fine stone slab, standing about 10 feet out of the ground, was found close to the old village site, and on each side were signs of two stone seats (as in sketch No. 4). We were unable to ascertain the history of these relics, none of the Chins being bold enough to talk of the place, which appears to have some superstitions attached to it.

Next day I returned and went south along the spur from Khovet, while Mahomed Latif went northwards. Neither of us got much work done, but I fixed the course of the Sum Tui Lui, our boundary stream.

On 21st February the Commissioner and I went back to Lengtang hill and fixed boundary pillar No. 6 on my theodolite station mark (see sketch No. 5). We cleared the hill leaving only a small rhododendron tree on the top and a big fir tree close to the top.

On 22nd February we marched south about 3 miles up the Tui Vai stream to its junction with the Sum Tui Lui, close to Chibu, the salt well, which is very well known, people coming from long distances to extract the salt from the water drawn from the well.

While looking about here, we came on three large stone slabs, planted vertically in the ground, a short distance from the well. Two of these had inscriptions on them, and on one was the arms of Manipur, and on the other the picture of a dog; on the third were two Burmese figures seated under umbrellas. The first stone stands 4′4″ high and the inscription on it records (in Manipuri) the fact that 2 Manipuri Majors and 130 officers and 2,000 men went there with General Nuttall, Political Agent, and having conquered 112 villages, Poiboi, Lenkam, etc., and taken possession of the well, placed there (on a slab at the foot of the stone) the footprints of the Rajah Chander Kirtee Singh, date 1872 (1793 of Sakabda).

On the second stone is inscribed 1872 in English and a dog, and it records the name of General Nuttall, Political Agent, year 1793 of the era "Sakabda." This also has a slab at the base, on which two naked feet are carved. One of the Majors mentioned on the first stone was the Thangal Major who died on the scaffold in Manipur in 1892.

On the 23rd February we marched by a most round-about way to the Tui Vel; the route we followed is that connecting the Nwengal and Nwite villages. At a short distance from the Tui Vai, we came across another slab, which had fallen down and was surrounded by a heap of stones, presumably a grave; the figures "171" were cut on it and also a figure of Hanuman, the monkey-god.

On 24th February I went back to fix the courses of the Chining and Salam streams, and we put up a stone on the watershed between these two streams.

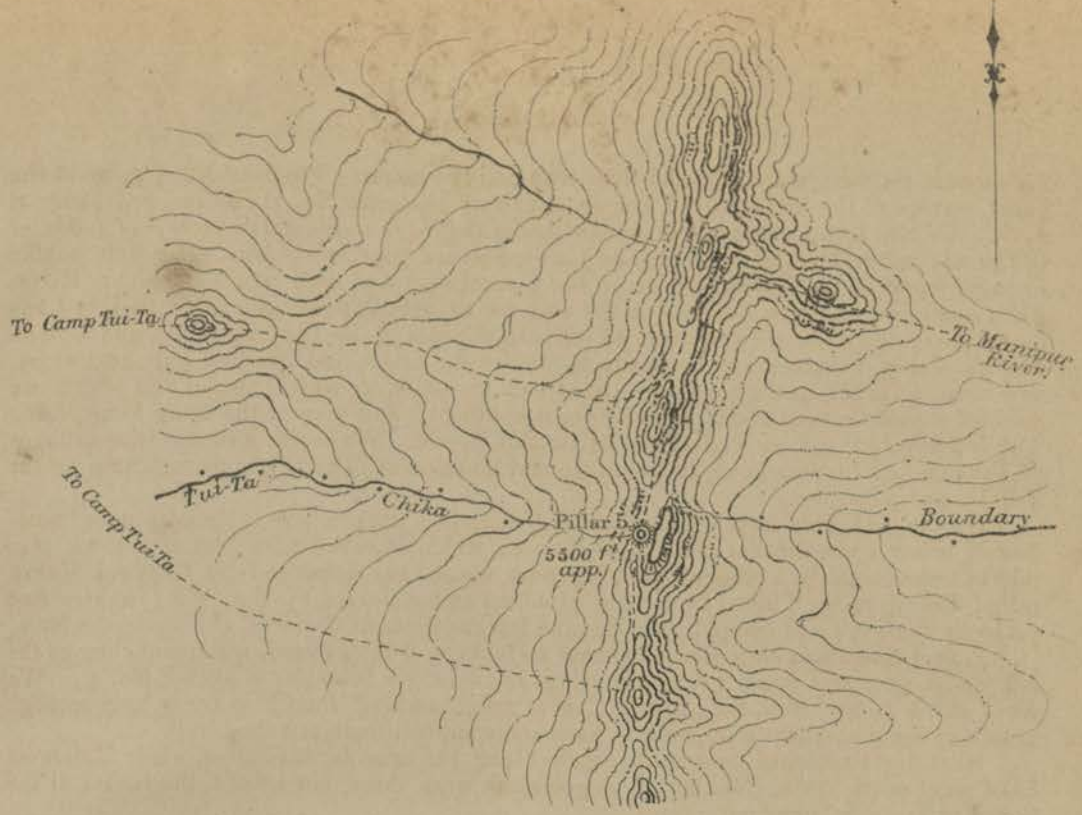
On the 25th February we marched to the Tui Mong. I got a good deal of work done, and Trydell and Kerr with some sepoys shot a magnificent solitary bull mythan.

On the 26th February we moved to the Tui Kui, about 3½ miles. It rained hard, but we put up a cairn and cleared a hill partly, on which we decided to erect the boundary pillar No. 8. This is at the head waters of four streams, the Tangha, the Tui Mong, the Tui Kui and the Tui Lak (see sketch No. 6).

It cleared up during the night and on the morning of the 27th we ascended Lunleng which was a stiff climb. On the Intelligence Branch map which we had with us, the height is given 1,000 feet below what it actually is, and consequently we were rather surprised at the amount of labour we had in reaching the top. The hill is scarped almost all round and the spur we ascended by was very steep; in one place we had to make a sort of ladder of saplings before we could progress at all. We eventually reached a sort of broken plateau, evidently the site of an old village, for, in addition to traces of buildings, we found remains of stone walls, ditches and gateways on the way up, closing gaps in the natural obstacles, and the position must have been almost, if not quite, impregnable from the east.

The highest point, which was trigonometrically fixed during the operations of the Left Column, Lushai Expeditionary Force, is 6,530 feet and is about a mile further on. It consists of a broad and densely wooded knoll, which it was impossible to clear, and after sketching as much of the neighbouring country as time and weather permitted, we started down the hill and were caught in a heavy storm when half way down, arriving in camp drenched and tired out at dark.

Sketch 3.

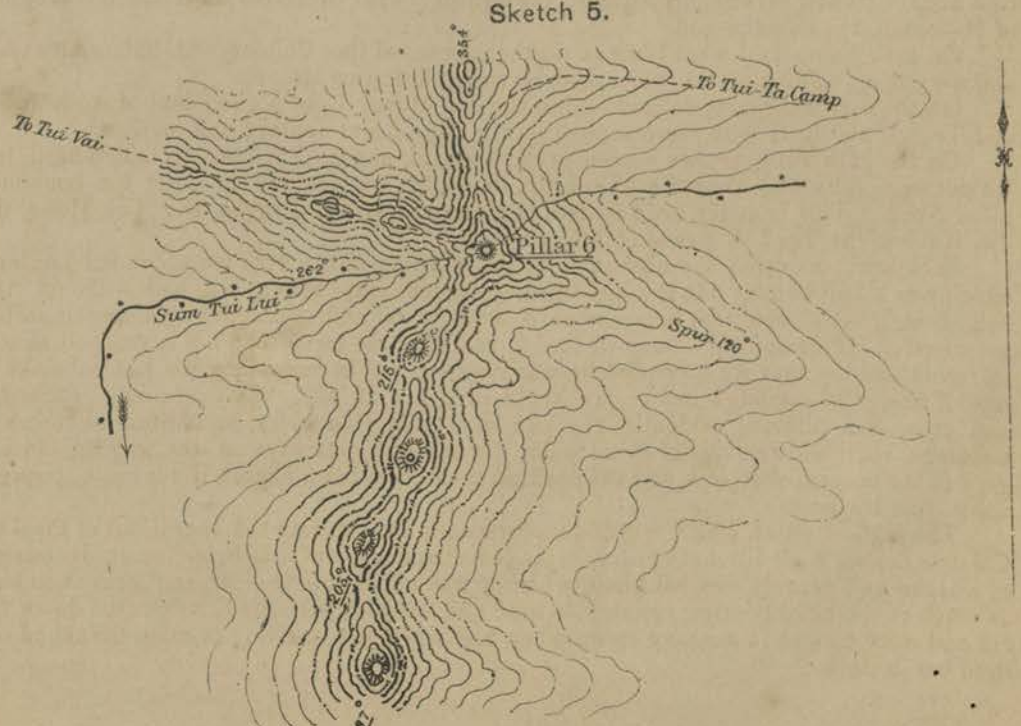


Pillar No. 5 is west of a small pool, which, when it overflows, pours its water into the Manipur River.

Sketch 4.

Old Stone Pillar and Seats on KHOVET HILL.

Sketch 5.



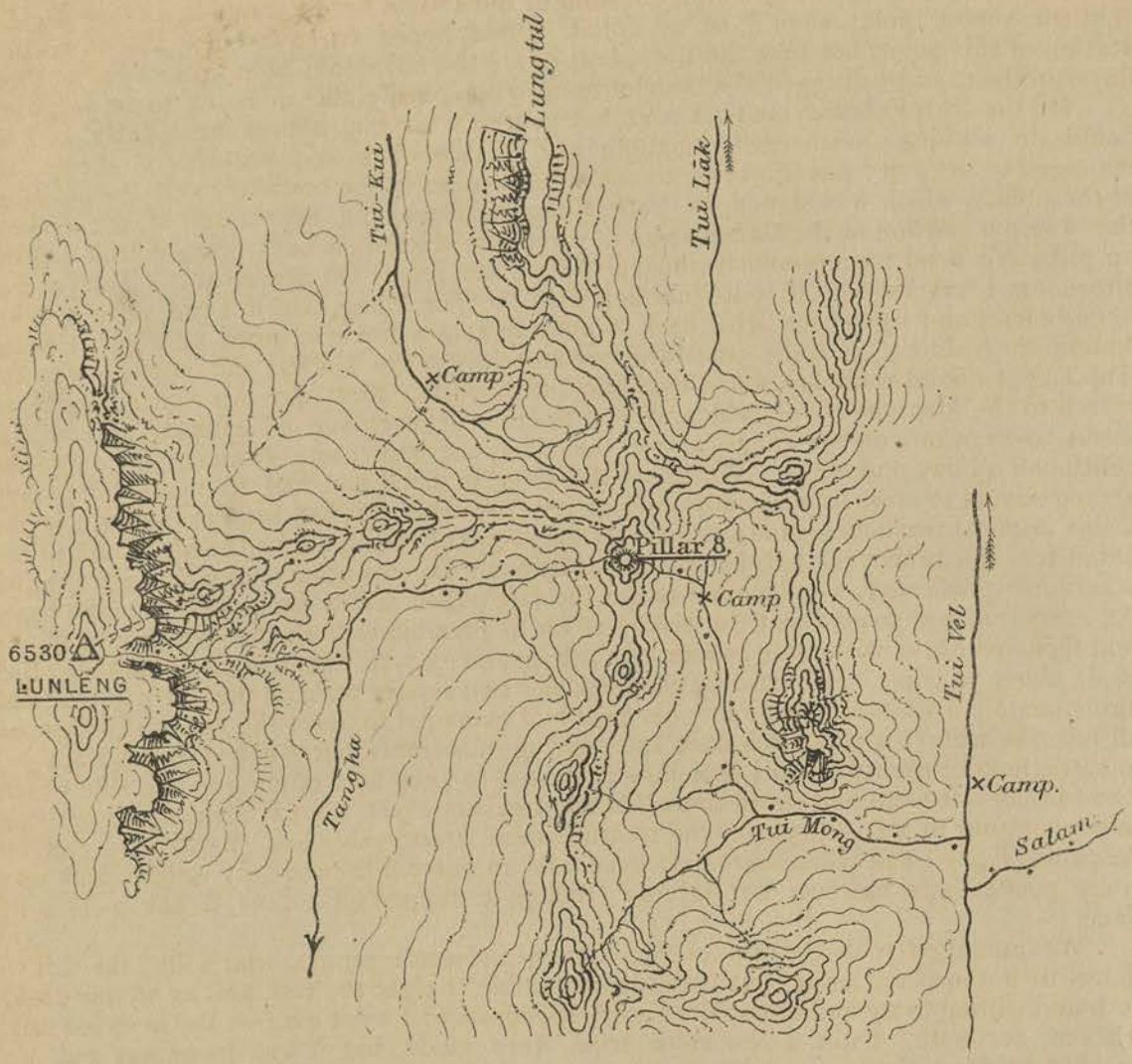
Pillar 6 is a Theodolite Station.
It is cleared with the exception of 1 Rhododendron tree and 1 Fir tree to the S. W. of the knoll.
It is on the LENTANG RANGE.

Reg. No. 613, S. I. D.—Dec. 94.—450.

Litho., S. I. O., Calcutta

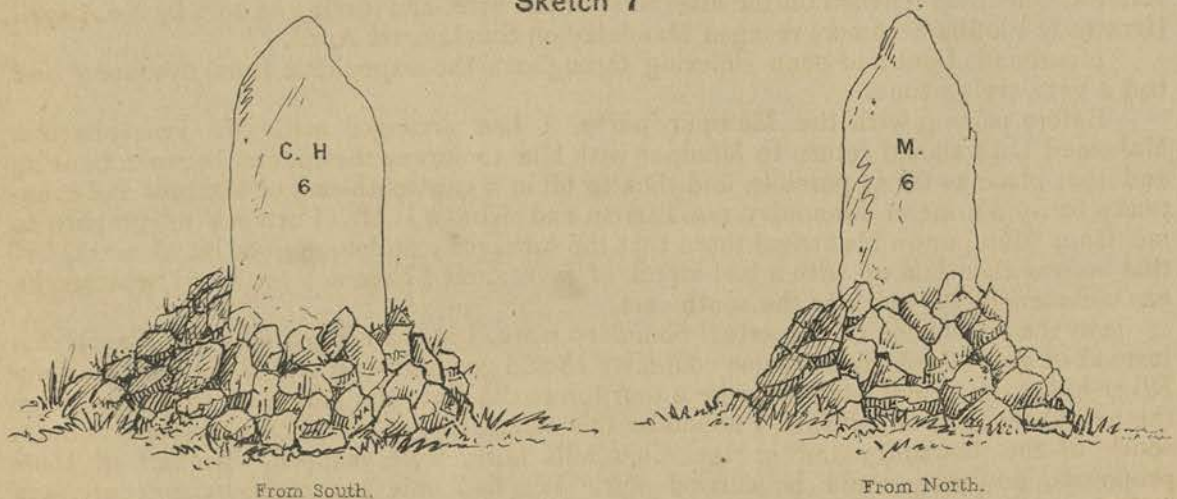
No. 417-S. 94.

Sketch 6.



Boundary shewn thus

Sketch 7



From South. From North.

Type of Boundary Pillar erected.

Reg. No. 643, S. I. D.—Dec. 94.—450.

Litho., S. I. O., Calcutta.

No. 418-S. 94.

This closed the boundary work, which was commenced on the 29th January. We erected no mark on Lunleng as the question of the Lushai border came in and we decided that the survey point should be accepted. I had hoped to have been able to make a station of this point, but time did not admit of it; the hill would have taken two or three days to clear, and I dragged the theodolite up with considerable difficulty to no purpose.

On the 28th February and 1st March it poured with rain almost incessantly, and we could do nothing; however by making use of tarpaulins and waterproof sheets, we managed to keep dry enough to write out a description of the boundary and the positions of the pillars, which was signed by both Commissioners, and on the 2nd March, leaving the Manipur portion of the Commission in camp, we started on our return march putting up pillar No. 8 on the previously chosen spot on our way. On arrival at the Tui Vai that afternoon, I traversed up it to its junction with the Tui Mong, which I had only roughly fixed before, and I got back after dark in pouring rain which continued all night, soaking us and our bedding. On the 3rd March we marched to the Tui Vai and on the 4th to the Tui Ta; it rained each day, and I could do little work. Next day we started early to march to the Manipur River, which we had to cross to reach our old camping ground: at about 10-30 when on the range above the river, the rain came down in torrents and continued all day and night. We found the river in flood and had to make temporary arrangements to cross as we had no rations left. A small raft had been prepared, and the Chins in about two hours made a sufficiently long rope of the fibre from the inner bark of the Odan tree to connect the two banks, and after many failures when my measuring rope and others had given way, we managed to get the raft pulled across with a loop over the rope. As every one was soaked and we wished as far as possible to keep the kits, etc., dry, we sent them over first, with three or four men a trip, and by 7-20 P.M., when I embarked, it had made about 30 trips. Ramdas, my chaprasi, and two sepoys were on the raft with me, and unfortunately a Chin also, who lost his head and managed to upset the raft and throw us all into the water: it was pitch dark and pouring in torrents, but we luckily all managed to catch hold of the raft, and I somehow contrived to keep hold of my gun and rifle which I had in my left hand and saved them, but the treasure chest, a box of ammunition and one rifle belonging to the sentry over the treasure were irretrievably lost. My camera and all the photographs I had taken were destroyed, and an aneroid injured; my watch which was in my pocket was however not injured; though it stopped for a time, it has gone well since.

We managed with the aid of Mr. Carey, and some sepoys, who pulled the raft to shore, to get on land again, but found it impossible to right the raft, and as no one could be found willing to try and cross, Mr. Carey, Ramdas and I went over on the inverted raft, without accident. Later a few more trips were made, but it was dangerous and we decided to leave the few remaining men and coolies on the far bank for the night. They were supplied with food and tarpaulins from our side and had lighted big fires, and we gave them whiskey from a case they had in their charge: no one was any the worse next day, when by 11 A.M. or noon all had been assembled in camp. The raft was righted and worked satisfactorily next day.

We halted on 6th and 7th March at the Manipur River (which continued to rise) in the hopes of recovering the lost cash chest, etc., but it was hopeless; it rained heavily each day and on the 8th we marched to Shielmong. On the way Mr. Carey received letters urging him to hurry back to Tiddim; so we pushed on, reaching Tunzan, which is Hauchinkup's head quarters, on the 11th March. Here we halted one day and on the 14th we reached Tiddim. There was nothing of any interest on the march; the route has been traversed several times before, but I found the position of Lenacot (Shielmong), very much out on the Survey map.

I halted at Tiddim till the 23rd March, when Lieutenant Dent and I marched to Kalewa, which we reached on the afternoon of the 27th, and leaving on 29th by the *Amyen* (Irrawady Flotilla Steamer) reached Mandalay on Sunday, 1st April.

Lieutenant Dent had been suffering throughout the expedition from dysentery and had a very trying time.

Before parting with the Manipur party, I had arranged with Mr. Porteous that Mahomed Latif should return to Manipur with him to survey the country between Lunleng and that place as far as possible, and then to fill in a gap south-east of Manipur and eventually to re-join me at Mandalay *viâ* Tammu and Kindat. Mr. Porteous telegraphed to me from Manipur on his arrival there that the surveyor had done a good bit of work, but that he was then laid up with a bad attack of fever, and I have not yet heard whether he has commenced his work to the south-east.

On the conclusion of the actual boundary work, I had arranged with Mr. Carey that instead of going back by the same route, we should go south-east and strike the Manipur River lower down and later on make a tour for 10 days into the hills west oft he river from the neighbourhood of Tunzan: I hoped by this means to get all the unexplored country south of the boundary and in the Chin hills fairly well mapped. Neither of these proposals, however, could be carried out. We had only a certain number of days' rations, and were therefore, after losing so many days through rain and the unfortunate delay at the Manipur River, obliged to march straight back to Tunzan, and then owing to the trouble with the Pimpi people, Mr. Carey and the escort were required for other duties and the expedition had to be abandoned. However, it was arranged that if possible it should be carried out next field season.

My survey work was necessarily limited to a very small distance on each side of the boundary, as the jungle made it often very difficult to follow the course of the boundary streams, and we had several times much trouble in finding a suitable place for our boundary pillar: on one occasion it took us three days to find the source of a stream within 3 miles of our camp, namely the Kengyoidong. We were also very limited as to time, first because Mr. Porteous had been informed that he must be at Manipur to meet the Chief Commissioner of Assam on the 27th February, and secondly on account of the difficulty of rations and the fact that there was very important work for Mr. Carey to the south.

I, however, managed to survey an area of about 840 square miles, exclusive of what Mahomed Latif may have done, and observed at three stations, and hope to have secured a connection between the various triangulations which have common points in this district, which common points, however, differ a good deal in position. It was to be regretted that the last portion of the work was so much interfered with by the rain, which for several days prevented work of any description being carried out.

As regards health, too, I was unfortunate; owing to the difficulty of getting transport, I only took with me eleven followers for the two parties, and of these five got more or less seriously ill and were for a great part of the time incapacitated, three having to be carried on the march. This was a good deal due to their being too lazy to put grass under them at night, I fancy, as they had tents, which no one else except Mr. Porteous had, and they were well fed, clothed and looked after.

A rough sketch is attached showing approximately the section along the boundary. The heights are from boiling point observations taken chiefly by Lieutenant Dent, and are only approximate. A detailed description of the boundary is not given, as this has been carefully described and forwarded to Government by the Political Agent. The type of boundary pillars that have been erected is shown in sketch No. 7.

Mahomed Latif carried out his duties to my satisfaction.

My best thanks are due to Messrs. Carey and Porteous for the great assistance they gave me, in clearing and many other ways, for they almost invariably remained with me all the time I was at work and personally supervised the coolies, etc., thus saving me much time and trouble.

The country through which we passed was densely wooded, but the undergrowth was in most cases not heavy, which enabled us to move with comparative freedom in this deserted tract, which is almost entirely devoid of paths. The only villages we went to or near were Haulkam and Hernzan on the east of the Letha Range, and Shielmong (formerly Lenacot), Kunum, Yangdung and Tangsi on the western slopes. On the west of the Manipur River the country is entirely deserted for several miles north of the boundary, and for a very long distance to the south, though hunting parties go there for shooting and also to Chibu for salt. Game of all kinds is very plentiful and there is no scarcity of water.

There are magnificent pine trees and the largest rhododendrons I have seen anywhere; we also came across a tree with a flower resembling in appearance and smell a magnolia, though the flower was considerably smaller.

The villagers live in the utmost state of filth and appear very poor. They all drink a liquor obtained from millet which is fairly pleasant to the taste and is refreshing. It can be made very strong, but is not so as a rule and they swallow gallons of it.

The women appear dirtier than the men, but when young have rather pleasant faces, and all seemed to have every confidence in us and many accompanied us as coolies.

There were no signs of any mineral wealth.

The hill sides are generally very steep, and the ridges except in the case of the summits of Khovet and Lunleng are extremely narrow, in many cases only a few feet wide.

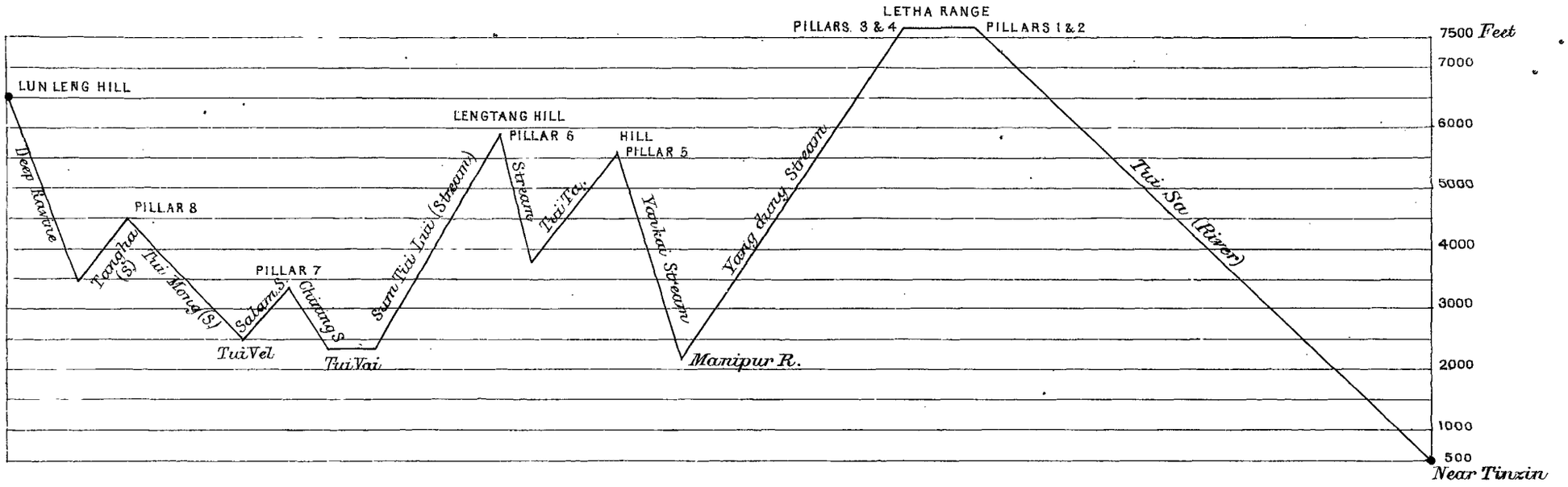
Over the Tui Sa between Tinzin and Haulkam, there is a bamboo suspension bridge, over which one man can go at a time, and the same over the Tui Pu, below Hernzan. Most of the streams are full of fish, but they do not seem to take either a fly or any artificial bait.

SOUTHERN SHAN STATES.

Narrative Report of CAPTAIN P. J. GORDON, S. C., *Assistant Superintendent, 1st grade, No. 21 Party, on the operations in the* SOUTHERN SHAN STATES, *Season 1893-94.*

Leaving Mandalay on the 22nd of November 1893, I arrived on the 30th at Thamakan, which it had been decided to make the head quarters of the detachment which was to carry on the one-inch survey in the Southern Shan States. Thamakan is on the cart-road, 72 miles from Meiktila Road station and 36 miles from Fort Stedman; it has a Post and Telegraph Office, and is the head quarters of the Myelat. In order to furnish points for the plane-tablers, we at once commenced the triangulation, starting from the Sintaung-Myinmati base of the Mönghsat secondary series of the Great Trigonometrical Survey Mr. James extending southwards, while I worked to the north of Lat. 20° 30″. On the 12th December 1893, I met Captain Longe at Kalaw, and we observed together at five stations and computed sufficient points to start the four available plane-tablers at their work on the 7th of January 1894.

On this date Captain Longe left for the Chin-Manipur Boundary Commission, and I continued the triangulation and was able to furnish points to Mr. Kennedy and two



ROUGH VERTICAL SECTION ALONG CHIN-MANIPUR BOUNDARY.

Horizontal Scale 1 Inch = 6 Miles.

Reg. No. 643. S I. D.—Dec. 94.—450.

Litho., S. I. O., Calcutta.

No. 419-S. 94.

sub-surveyors on their arrival from Lashio on the 29th of January. In the meantime, Mr. James was working to the south to furnish points in advance for next year's work. After the end of March triangulation had to be abandoned owing to the haze and the smoke of jungle fires.

The total out-turn of triangulation for the season was 2,370 square miles, furnishing points for the two sheets completed this year, and in advance for a large portion of four more sheets, which it is intended to take in hand next field season.

During April, Messrs. James and Kennedy were employed in putting in the Burma-Shan and the State boundaries. These were, as a rule, entered on the plane-tables *in situ*, and as each plane-table section contained several boundaries, this plan secured an additional test of the work. As a rule, boundaries were clearly defined, but in one or two cases there was a difference of opinion between the Chiefs of adjoining States. In such cases both boundaries as claimed were entered on the plane-table section and traces of them sent to the Superintendent for decision.

Owing to the absence of advance triangulation, plane-tabling had to be carried on in very small sections. The total out-turn of topography on the 1-inch scale comprised an area of 1,064 square miles in sheets Nos. 311 and 312. The lateness of the start and the inexperience of many of the surveyors rendered the outturn comparatively small.

The climate of that part of the Shan States in which we were working is excellent, and, with the exception of a few cases of fever contracted in coming through the malarial terai tracts, near Nampandet, the health of the detachment was uniformly good. There is now a good cart-road from Meiktila Road station to Fort Stedman, and a tonga service might be organized, which would take one from Rangoon or Mandalay to a climate as good as Bangalore or Dehra Dun in little over 24 hours. Although the average height of the plateau is only 4,000 feet, the heat is never excessive, and in December, January and February the ground in the early morning is thickly covered with hoar frost. Although the country does not possess all the requirements of a sanitarium, it is doubtful whether there is any more suitable place in Burma for one, within easy access of the plains.

After passing the fringe of wooded *ghats* on the western edge of the plateau, one comes out on a wide expanse of rolling grass-covered downs, broken in places by deep red canons—a most characteristic landscape of the Shan country. To the east successive ranges of limestone hills running north and south separate the valleys and the plateaux. All the curious phenomena of a limestone region are seen among these hills: deep rounded basins with no outlet, blind valleys, and caverns, many of which have their sides encrusted with figures of Gautama, and are considered of great sanctity. Some streams disappear altogether on one side of a hill and after running underground for a considerable distance come gushing out at the other side.

The country is rich in minerals; lead ore is extensively mined in the Bawsaing State, where the ubiquitous Chinaman, who is always to the front where money is to be made, holds the contract for smelting lead and silver. The possession of this mineral wealth is not a source of unmixed benefit to the State, as the surrounding hills are so honeycombed with old mines, that the people are unable to keep cattle, grazing being impossible owing to these pit-falls. Coal of fair quality is found in Pwehla, and copper and iron were both formerly mined for in the Myelat.

From an ethnological point of view, the country is most interesting. In the Myelat there are over twenty different tribes distinct in dress, customs, and often language. These tribes do not, as a rule, intermarry. Although so different otherwise in character, they resemble one another closely. They are unambitious and unenterprizing people, but cheerful and fond of amusement, and although constitutionally lazy, take care to work sufficiently hard to keep themselves in comfort. The wife does all the house work and a very large share of the out-door work as well. So important a member of the household is she considered that in most of the States a widower is exempt from all taxation.

The Shan is a born trader, and the great feature of life in this country is the bazar, which is held on every fifth day at all the chief villages of States. There the gossip of the neighbourhood, as well as its produce, is exchanged, and for the few hours in the forenoon while they last, these markets present scenes of much animation. Our detachment found them most convenient, as fresh vegetables, fruit, and fish, and sometimes meat were to be bought there.

During the colder months, an extensive trade is done between the Shan States and Burma, and the traders from the States east of the Salween with their immense herds of fine pack cattle, preceded by a favourite bull carrying a deep-toned bell hung on a wooden arch on its shoulders, are continuously passing to and from the plains, principally along the cart-road, although a little of the trade finds its way by the old routes *viâ* the Natteik Pass to Kyaukse, and by the southern road to Yamethin and Pyinmana. The cart-road leading from Meiktila Road station to Fort Stedman and Taunggyi is a wide metalled road with easy gradients: it is intended to eventually carry it on to Moné and the eastern States. Besides it there are a few cart tracks in Thamaingkan, Pwehla, and Pindaye States, and a number of excellent bullock tracks throughout the district.

The only rivers of any importance are the Panlaung, Balu, and Paung Laung chaungs, but they are not navigable except for rafts in the parts we were surveying this season. The Inle lake (Nyaungywe State) with its influents in the valley is much used as a means of communication, and to the south the Balu chaung, which flows out of the lake, is the principal highway of that portion of the country. The boats are all owned and

navigated by an amphibious tribe, the Inthas, said to have been originally brought from the Tavoy province. They build their villages on piles in the lake and construct floating gardens close by, where tomatos, water melons and gourds grow in profusion. They are expert fishermen, and supply all the bazars in the neighbourhood with fish.

Their method of rowing is peculiar; the boatman, or woman, for both are equally expert, holds the end of the paddle in the hand, and propels it by the leg which is hooked over the handle for this purpose.

With the exception of Nyaungywe and Fort Stedman, there are no towns in the district, even the capitals of States being mere villages.

The country is generally fertile. Rice, of course, is the principal crop, but a little wheat, cotton and sugarcane is also grown, and in some parts good crops of earth-nuts are obtained. Excellent oranges are grown in Pindaya and other favoured spots, and, judging from the size and appearance of the wild apple and peach trees, there should be no difficulty in cultivating these fruits also. The only opium I saw was in a small Palaung village among the Pindaya hills where rich crops of opium, bhang, and tobacco were grown in forest clearings.

The natives showed a considerable amount of interest in the survey, and helped us as much as they could, except when the counter-attraction of a Poongyi's funeral or of a day's gambling proved too great for them.

The country is thoroughly settled and peaceful, and we all moved freely throughout the district without escorts of any kind.

For carriage, pack-bullocks and coolies are generally procurable, but for purposes of triangulation, it is advisable to employ mules, their extra cost being amply repaid by the increased out-turn which they render possible.

The survey was carried on in 18 States and Sub-States of which 9 were surveyed in full and 9 in part. They vary much in size, some of them being very small, *e.g.*, Nankon, whose whole area is less than 4 square miles, while others such as Nyaungywe cover over 500 square miles.

The following are the names of the Shan States, with their areas, the survey of which was completed during the season :—

	Square miles.
States—	
Pwehla (including Sub-States of Tatpot and Myinmu)	101·6
Nankon	4·0
Kyon	24·4
Bawnin	40·0
Pinhmi	29·3
Sub-States—	
Kalaw (of Nyaungywe State)	5·6
Kyawktat (do. do.)	49·0

Owing to the excellent arrangements which Mr. Hildebrand, C.I.E., Superintendent of the Southern Shan States, had made, and to the hearty co-operation of his staff, we had no difficulties, except those due to the nature of the country and the state of the atmosphere. Mr. Giles, who had charge of the Myelat, rendered me the greatest assistance.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1893-94.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Sheets Nos. 21 S. E., 24 S. E., 31 N. W., 34 S. W., 46, 47, 48, 49, 49 N. W., 59, 60, 61, 61 N. W., 65, 66, 66 S. E., 66 S. W., 67, 67 N. W., 67 N. E., 69, 69 N. E., 69 S. E., 70 N. W., 70 S W., 71 N. W., 72 S E., 77, 79, 87, 87 N. E., 87 S. E., 91 N. W., 91 S. W., 92 N. E., 102, 104, 106, 107, 108, 111, 112, 113, 114, 115, 116, 118, 119, 120, 121, 125 N. E., 125 S. E., 125 N. W., 126 N. E., 126 S. E., 127 N. E., 127 S. E., 129 N. E., 130 N. W., 130 S. W., 131 N. W., and 131 S. W.	1=4	62	Additions made to railways, roads, canals, and changes to boundaries.
Sheets Nos. 24 S. E., 36 S. W., 37 N. W., 49 S. W., 59 N. E., 68 S. W., 77 S. W., and 78 N. W.	1=4	8	Additions made to names and detail for engraving.
Sheets Nos. 21 N. W., 31 N. W., 40 S. W., 48 N. W., 50 S. W., and 59 N. W	1=4	6	Additions made to names and detail, in progress.
Sheets Nos. 11 S. W., 23 N. E., 37 S. W., 40 S. W., 42 N. E., 42 S. W., 48 S. E., 49 S. W., 59 S. E., 59 N. W., 60 S. E., 61 N. E., 66 N. W., 68 S. W., 76 N. E., 76 S. W., 77 S. E., 77 S. W., 78 N. E., 78 N. W., 78 S. W., 79 N. W., and 87 N. E.	1=4	23	Hills brush-shaded for engraving.
GENERAL MAPS.			
India (lithographed)	1=32	6	3rd edition, in progress.
Do. (engraved) (without hills)	1=32	6	2nd ditto ditto.
Do. (showing railways)	1=48	4	Railways inserted to March 1894.
Do.	1=64	4	Additions and corrections.
Do.	1=128	1	Brought up to date for general report.
Do.	1=256	1	Additions and corrections to date.
Burma and adjacent countries	1=32	2	Boundaries corrected to date.
Indo-China	1=32	2	Compilation completed and published.
PROVINCAL MAPS.			
Bengal, Behar, Orissa and Chota Nagpur	1=32	1	Additions and corrections made to date.
North-Western Provinces and Oudh	1=32	...	Ditto ditto.
Assam (engraved)	1=16	1	Ditto ditto.
Bengal	1=8 & 16	14 & 2	Ditto ditto.
Bombay	1=16	1	A new compilation in progress for engraving.
Central Provinces (engraved)	1=16	2	Additions and corrections made to date.
Madras	1=16	5	A new compilation in progress for engraving.
Mysore	1=16	1	Railway line inserted and brush-shaded hills for engraving.
Punjab	1=16	4	Additions and corrections made to date.
Rajputana	1=16	2	Ditto ditto.
Upper Burma (2nd edition)	1=16	2	Completed, under examination for press.
DIVISIONAL MAPS.			
Chota Nagpur	1=8	2	Completed for photography.
Chittagong	1=8	1	Ditto and published.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
DISTRICT MAPS.	In. M.		
Almorah Bankura Bhagalpur Bhamo Goalpara Garhwal Hazaribagh Howrah Jalpaiguri Kamrup Katha Minbu Nadia Naini Tal Puri Palámau Ruby Mines Singbhoom	1=4	18	Additions and corrections made to date.
STANDARD MAPS.			
ASSAM— Sheets Nos. 5, 10, 43, and 44	1=2	4	Additions made to roads.
BENGAL— Sheets Nos. 320, 343, and 344	1=1	3	Ditto.
BOMBAY— Sheets Nos. 119 and 340	1=1	2	Ditto.
CENTRAL INDIA AND RAJPUTANA— Sheets Nos. 335, 378, 408, 419, 462, 480, and 483 Sheets Nos. 26, 51, 363, and 382	1=1 1=1	7 4	Outline and printing in progress. Additions to railways.
MADRAS— Sheets Nos. 23, 24, 43, 44, 45, 46, 47, 56, 74, 79, 105, 106, 107, 108, 136, 137 and 138	1=1	17	Additions and corrections to roads and railways.
NORTH-WESTERN PROVINCES— Sheets Nos. 6, 9, and 26	1=1	3	Additions and corrections.
UPPER BURMA (NORTH-EAST FRONTIER SERIES)— Sheets Nos. 15 N.W. and 15 S W. Sheet No. 15 (4th edition) Sheet No. 22 (5th edition) Sheet No. 23 (2nd edition)	1=4 1=8 1=8 1=8	2 1 1 1	Outline and printing nearly completed. In progress. Completed and published. Do. under examination.
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)— Sheet No. 1 S. W. (4th edition) Sheet No. 2 N. W. and 2 S. W. Sheet No. 1 (4th edition) Sheet No. 3 A. (2nd edition) Sheet No. 4 (2nd edition) Sheet No. 5 (1st edition) Sheet No. 6 (2nd edition) Sheet No. 10 Sheet No. 13	1=4 1=4 1=8 1=8	1 2 1 6	Completed and published. Outline and printing nearly completed. Completed and published. In progress.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ADMINISTRATION REPORT MAPS.	In. M.		
BENGAL—			
Chittagong, Cuttack, Darjiling, Faridpur, Gurhjat, Hazaribagh, Hill Tippera, Hooghly, Howrah, Malda	1=8	10	Corrected to date for engraving.
Angul	1=16	1	Redrawn for engraving.
CENTRAL PROVINCES—			
Balaghat, Bilaspur, Betul	1=8	3	Corrected to date for engraving.
Chhindwara, Hamirpur, Hoshangabad, Mandla	1=8	4	Redrawn for engraving.
NORTH WESTERN PROVINCES—			
Almorah	1=10	...	Redrawn for engraving.
Garhwal, Naini Tal	1=8	...	Ditto.
PUNJAB—			
Hazara, Hissar	1=8	2	Redrawn for engraving.
Kangra	1=12	1	Ditto.
Karnal, Shahpur, Simla	1=8	3	Ditto.
Dera Ghazi Khan, Dera Ismail Khan, Gujarat, Hoshiarpur	1=8	4	Corrected to date for engraving.
Mooltan	1=16	1	Ditto ditto.
Muzaffargarh, Peshawar, Umballa	1=8	3	Ditto ditto.
INDEX MAPS.			
To illustrate progress of field parties	Various	15	Corrected to September 1894.
Central Provinces—Provincial, Hyderabad ditto	1=32	2	Additions and corrections.
MISCELLANEOUS MAPS.			
Table of topographical symbols	...	1	Prepared for engraving.
Andaman Islands	1=4	1	Drawn as a specimen for heliogravure.
Plans of roads, railways, canals, etc., received from Public Works Department	Various	31	Reduced to 1-inch and ½-inch scales and inserted on office copies.
WORK DONE FOR OTHER DEPARTMENTS.			
STATISTICAL MAPS.			
India illustrating British Provinces and Native States	1=32	8	Prepared for the Antwerp Exhibition.
Do. do. River Basins			
Do. do. Religions			
Do. do. Rainfall			

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
WORK DONE FOR OTHER DEPARTMENTS—contd.	In. M.		
STATISTICAL MAPS—contd.			
India illustrating Railways and Coal Mines .			
Do. do. Geology .			
Do. do. Physical Configuration .	1=32	8	Prepared for the Antwerp Exhibition.
Do. do. Density of Population . .			
Do. do. Crops, Rice and Cotton . .	1=64	3	Coloured for Secretary of State.
Do. do. Physical Configuration . .			
Do. do. Rainfall . .			
Do. do. Density of Population . .			
Do. do. Forests (1) class of . . .			
Do. do. Forest (2) limits of the distribution of the various kinds of trees .			
Do. do. Railways, Telegraphs, and steamship routes			
Do. do. British Provinces and Native States			
Do. do. Emigration to the Colonies .			
Do. do. Geology . .			
Do. do. Areas in the Southern Seas open to inland emigration .	1=192	8	
Do. do. Public Instruction in British India . .			
Do. do. Public and Private Instruction in British India . .			Pepared for the Statistical Atlas of India (2nd edition) for the Revenue and Agricultural Department.
Do. do. Horses and Ponies in British India and Mysore . .			
Do. do. Languages .			
Do. do. Canal systems .			
Do. do. Land Revenue system in British India and Mysore . .			
Do. do. Economic minerals, Economic Producs . .			
Do. do. Sheet (1) Cotton, Wheat, Rice, and Barley . .			
Sheet (2) Linseed, Jowar, Ginjelly, and Bajra .			
Sheet (3) Tea, Jute, Coffee, and Indigo . .	1=384	9	
Do. do. Religions (Sheet 1) includes prevailing religions in each tract, Hindus, Mohamedans, and Buddhists .			
(Sheet II) includes Sikhs,			

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STATISTICAL MAPS—contd.	In. M.		
India Illustrating Jains, followers of the animistic and aboriginal cults and Native-Christians .	1=384	9	Prepared for the Statistical Atlas of India (2nd edition) for the Revenue and Agricultural Department.
Do. do. Live stock .			
Do. do. Normal seasonal rainfall and mean temperature . . .			
Do. do. History of a small cyclonic storm in the rainy season .			
Diagram illustrating incidence of Land Revenue	...	4	
Do do. Education .			
Do do. Irrigration in India compared with areas of cultivation . .			
Do. do. progress of construction, etc., of Railways in 1892.			
Bengal	1=80	1	Illustrating Collegiate and secondary education.
Do.		1	Do. Female ditto.
Do		1	Do. Primary ditto.
Do.		1	Do. Mahomedan ditto.
Do.		1	Do. death-rate from small pox, fever, and cholera.
Central Provinces . . .		1	For Chief Commissioner.
MISCELLANEOUS MAPS.			
Central India and Rajputana Sheets Nos. 348, 349, 369, and 370	1=1	4	Corrected for Director of Land Records, Gwalior States.
District Puri	1=4	1	Inserted Pargana boundaries and names for Chairman, District Board.
Mysore	1=16	1	Additions and corrections for the Diwan of Mysore.
India	1=32	6	Prepared for Viceroy, showing railways to date.
Umerkot-Pachpudra Railway map	1=32	1	For Engineer-in-Chief.
Upper Burma	1=64	1	Brought up to date for Sanitary Commissioner's report.
India	1=96	10	Showing opium grown in British Teritory and Native States for Mr. Hart, Secretary, Opium Commission.
A map of the Viceroy's tour, 1894	1=96	1	Prepared.
MAPS, COLOURED, ETC.			
Maps on various scales . .	...	1,336	For Surveyor-General's Office.
Ditto . .	...	433	For other Departments.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

Description of Work.	Number of Sheets.
Maps examined.	
Atlas sheets	51
General maps	26
Provincial maps	23
Divisional maps	3
District maps	6
Standard maps	48
Administration Report maps	41
Index maps	31
Statistical and extra-departmental maps	157
Miscellaneous maps	161
Office copies of various maps, with additions and corrections in territorial boundaries and public works	281
Tracings of roads, canals, and railways from originals supplied by Public Works Department	101
Engraved proofs of atlas sheets in various stages	87
Engraved proofs of large scale plans	15
Engraved proofs of general and provincial maps, including index charts	42
Engraved proofs of administration report maps	53
Litho. proofs of general and provincial maps, including index charts	17
Litho. proofs of district maps transferred from copper plates	23
Litho. proofs of statistical and extra-departmental maps	28
Photo. proofs of standard and various other maps	355
Colouring of maps for various purposes	505
Projection and examination of graticules and plotting of points	38
Total	2,092

N. B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof sheets of the catalogue of maps and charts of Burma and of the "Survey of India Notes," as to the correct orthography of geographical names, have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE.

Statement showing the work performed during the year 1893-94.

TITLE.	Scale.	Number of sheets.	REMARKS.
STANDARD MAPS.	In. M.		
PUNJAB.			
Districts Umballa and Ferozepore.			
Sheets No. 213 and 214 . .	1=1	2	Proofs passed; press order given.
District Peshawar.			
Sheet No. 6 (portions of new Nos. 79 and 80) . . .	1=1	1	Proofs examined and returned to press for correction.
District Hazara.			
Sheets Nos. 3, 4, 5, 6 7, and 8 .	1=1	6	Proofs passed; press order given.
„ Nos. 3, 5, 6, and 7 . .	1=1	4	Additions and corrections made to boundaries.
Indus Riverain Survey.			
Sheets Nos. 40, 59 (60 and 81), 78, 79, 80, 98, and 99 . . .	1=1	8	Fair maps examined with plane-table sections; corrected and sent to press for reproduction; proofs passed; press order given.
Sind and Bahawalpur disputed boundary survey.			
Sheets Nos. 98 S. W., 98 S. E., 99 N. W., 99 N. E., 99 S. E., 115 N. W., and 115, S. W. .	2=1	7	Ditto ditto.
District Jhang.			
Sheets Nos. 118 and 144 . .	1=1	2	Examined with Executive Engineer's 2-inch maps of the Jhelum and Chenab river survey maps.
NORTH-WESTERN PROVINCES AND OUDH.			
Districts Naini Tal (including portions of late Tarai and Kumaun Districts), Bijnor, and Moradabad.			
Sheets Nos. 46, 97, 98, 250, and 251	1=1	5	Proofs passed; press order given.
Sheets Nos. 63, 64, 65, and 81 .	1=1	4	Proofs corrected and sent to press for completion.
Rampur State and Moradabad.			
Sheets Nos. 47, 48, 49, 50, 64, 65, 66, and 67 . .	2=1	17	Fair maps examined with 16-inch plans, corrected and sent to press; proofs under examination.
Districts Meerut, Bulandshahr and Moradubad.			
Sheet No. 32	1=1	1	Proofs passed; press order given.
Districts Budaun, Bareilly, Pilibhit and Kheri.			
Sheets Nos. 65, 66, 67, 68, 81, 82, 83, 84, 98, 99, and 100 . .	1=1	11	Names corrected to new spelling, drawing touched up and white leaded for reproduction; proofs examined.
District Budaun.			
Sheet No. 50	1=1	1	Additions and corrections made to boundaries.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
NORTH-WESTERN PROVINCES AND OUDH—contd.			
Districts Ghazipur and Ballia.			
Sheets Nos. 209, 210, 218 and 219	1=1	4	Additions and corrections made to boundaries.
District Bahraich.			
Sheet No. 146	1=1	1	Proofs passed; press order given.
Districts Fyzabad, Sultanpur, and Jaunpur.			
Sheet No. 178	1=1	1	Fair maps corrected and sent to press; proofs under examination.
Districts Lucknow and Rae Bareli.			
Sheets Nos. 135 and 136 . .	1=1	2	Additions and corrections made to boundaries.
District Hamirpur.			
Sheets Nos. 3, 4, 6 and 7 . .	1=1	4	Ditto ditto.
District Muttra.			
Sheets Nos. 11, 12 and 23 . .	1=1	3	Ditto ditto.
District Bijnor.			
Sheets Nos. 2, 3, 4, 5, 6 and 7 .	1=1	6	Ditto ditto.
Portion of the Naini Tal (late Kumaun) District.			
Sheet No. 46 $\frac{N.E.}{2,4}$, $\frac{S.E.}{2}$; No. 63 $\frac{N.W.}{1,3,4}$, $\frac{N.E.}{3}$, $\frac{S.W.}{1,2,3,4}$, $\frac{E.S.}{1,3,4}$; No. 64 $\frac{N.E.}{1,2,3,4}$, $\frac{S.E.}{2}$; No. 250 $\frac{S.W.}{3}$; and No. 251 $\frac{N.W.}{1,2,3,4}$, $\frac{S.W.}{1,2,3,4}$, $\frac{S.E.}{1,3}$	4=1	30	Proofs passed; press order given.
District Jhansi.			
Sheets Nos. 39A, 41, 56A, 57, 58, 59, 77, 79 and 80 . . .	1=1	9	Dtto ditto.
BENGAL.			
Districts Balasore and Cuttack.			
Killa Kanika.			
Sheets Nos. 221, 222, 247 and 248	1=1	4	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
BENGAL—*continued.*			
District Cuttack.			
Killa Kujang.			
Sheets Nos. 195 and 196 . .	1=1	2	Proofs passed; press order given.
Sheets Nos. 223 and 224 . .	1=1	2	Proofs returned and sent to press for correction.
District Darjeeling (including British Sikkim.)			
Sheets Nos. 269 and 270 . .	2=1	4	Touched up and corrected for reduction to 1-inch scale.
Sheet No. 292	1=1	1	Proof returned to press for correction.
Districts Darjeeling, Jalpaiguri and Purnea.			
Sheet No. 271	1=1	1	Proof passed; press order given.
Districts Darjeeling and Jalpaiguri.			
Sheet No. 293	1=1	1	Proof held in abeyance pending receipt of 2-inch fair map of District Jalpaiguri of the new survey.
District Faridpur.			
Sheets Nos. 2 and 4 . . .	1=1	2	Additions and corrections made to boundaries.
District Hazaribagh and Sonthal Parganas.			
Sheet No. 207	1=1	1	Proofs passed; press order given.
District Mymensingh.			
Sheet No. 359	1=1	1	Ditto ditto.
Sheets Nos. 375, 376 and 388 .	1=1	3	Proofs examined and sent to press for corrections.
Sheets Nos. 348, 349, 359, 378, 388 and 391	1=1	6	Proofs await receipt of unpublished prints from the district officials.
ASSAM.			
District Lakhimpur.			
Sheets Nos. 84, 85, 99, 100, 115 and 131 (4 sections in each) .	2=1	12	Completed and held in abeyance for completion to margin.
District Sibsagar.			
Sheets Nos. 99, 100, 115 and 131 (4 sections in each) . .	2=1	16	Drawing in progress.
District Kamrup.			
Sheet No. 10	1=1	1	Additions and corrections made to boundaries.
BOMBAY.			
Sheets Nos. 158, 159, 183, 240, 272, 273, 57 and 85 . .	1=1	8	Proofs passed; press order given.
Sheets Nos. 160 and 174 (4 sections in each)	2=1	8	Fair maps corrected and sent to press.
Sheets Nos. 167, 168, 169, 224, 227, 228, 270, 275 and 276 (4 sections in each) . . .	2=1	36	Fair maps touched up and corrected for reprints.
Sheets Nos. 175, 206, 241 and 303	1=1	4	Corrections made to boundaries.

DRAWING OFFICE, CALCUTTA.

SECTION No. H—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*concld.*	In. M.		
LOWER BURMA.			
Sheets Nos. 232 and portion of 279	1=1	1	Fair maps corrected ; proofs passed, and press order given for 2nd edition.
Sheets Nos. 234, 235, 236 and 237	1=1	4	Proofs passed ; press order given.
Sheets Nos. 181, 182 and 231 (4 sections in each)	2=1	12	Corrected up to date and sent to press for reprints.
Sheet No. 179 in 4 sections	2=1	4	Corrected up to date and sent to press for reprints ; in progress.
District Mergui.			
Sheets Nos. 563, 564, 570, 571, 572, 572A, 579, 580 and 581	1=1	9	Fair sheets completed and sent to press for reproduction. Proofs passed ; press order given.
UPPER BURMA.			
District Kyaukse.			
Sheets Nos. 261, 262, 263 and 264	1=1	4	Ditto ditto.
District Mandalay.			
Sheets Nos. 258, 259, 260 and 261 (4 sections in each)	2=1	13	Examination with the 16-inch plans in progress.
PARGANA MAPS.			
BENGAL.			
District Bogra.			
Main circuits Nos. 1, 2, 3, 4 and (6, 8)	1=1	5	Prints touched up, corrected and sent to press for reproduction.
District Bhagalpur.			
Sheet No. 9	1=1	1	Ditto ditto.
District Chittagong.			
Parganas Nizampur, Mascal, Kutubdia	2=1	8	Ditto ditto.
Thana Pattia, Chakeria, Satkania, and Cox's Bazar	1=1	5	Ditto ditto.
District Champaran.			
Sheet No. 6	1=1	1	Additions and corrections made to boundaries.
District Darjeeling (Daling Subdivision).			
Main circuits Nos. 1, 2 and 3	2=1	4	Printed maps touched up, corrected and sent to press for reproduction.
District 24-Parganas.			
Dhee Panchanogram. Government Estate in 11 sheets	14=1	11	Fair maps touched up, corrected and sent to press for reproduction by photography.
Ditto ditto.			Proofs completed with borders and passed ; press order given.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PARGANA MAPS—*contd.*	In. M.		
BENGAL—*contd.*			
District 24-Parganas—contd.			
Dhee Panchanogram Government estate in 11 sheets.			
Grand division 5 . . .			
Sub-division J	1=99 ft.	1	Printed maps touched up, corrected and sent to press for reproduction.
Grand division 6 . . .			
Sub-divisions, I. P. T., etc. . .	1=99 ft.	3	Proofs passed ; press order given.
District Jalpaiguri.			
Forest Survey.			
(Apalchand Malhati), Dumchi Dalgaon (Goshainhat and Salbari), Titi, Salkumar, Khairanti, Lower Tondu, Upper Tondu, Dianah Maraghat, Rehti, Khairbari, North Borajhar, South Borajhar, Gabur Basra, Bhutri, Buxa Raydak, Dhumpara and Bhalka	4=1	33	Proofs joined into separate forest blocks, completed and passed ; press order given.
District Patna.			
Sheets Nos. 1 and 3 . . .	1=1	2	Additions and corrections made to boundaries.
District Saran.			
Sheet No. 14	1=1	1	Printed map touched up, corrected and sent for reproduction ; press order given.
District Shahabad.			
Sheets Nos. 2 and 7 . . .	1=1	2	Additions and corrections made to boundaries.
Ganges River Survey.			
Main circuits Nos. 1, 2, 7, 8 and 9	1=1	5	Ditto ditto.
District Faridpur.			
Sheets Nos. 32, 33, 34 and 40 .	4=1	4	Ditto ditto.
DISTRICT MAPS.			
Punjab.			
Peshawar	1=4	1	Ditto ditto.
Gujranwala	1=2	2	Publication deferred pending receipt of proofs from the local officials.
North-Western Provinces and Oudh.			
Gorakhpur	1=2	6	Proofs passed ; press order given.
Mirzapur	1=2	6	Proofs being examined and corrected.
Garhwal	1=2	4	Fair maps drawn and sent to press for publication ; proofs received and sent out to the local officials.
Almora	1=2	6	Drawing completed.
Naini Tal	1=2	4	Drawing in progress.
Lalitpur	1=2	2	Additions and corrections made to boundaries.
Jhansi	1=2	2	Ditto ditto.
Ghazipur	1=2	2	Ditto ditto.
Ballia	1=2	2	Ditto ditto.
Cawnpore	1=2	4	Ditto ditto.
Moradabad	1=2	4	Ditto ditto.
Bijnor	1=2	4	Ditto ditto.
Etah	1=2	2	Ditto ditto.
Hamirpur	1=2	2	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II.—*continued.*

Statement of work—contd.

TITLE.	Scale.	Number of Sheets.	REMARKS.
DISTRICT MAPS—*contd.*	In. M.		
Bengal.			
Bhagalpur	1=4	1	Additions and corrections made to boundaries.
Champaran	1=4	1	Ditto ditto.
Shahabad	1=4	1	Ditto ditto.
Assam.			
Darrang	1=4	1	Ditto ditto.
Nowgong	1=4	1	Ditto ditto.
Kamrup	1=2	1	Examined and proofs passed; press order given.
Darrang	1=2	1	
Nowgong	1=2	2	
Sibsagar	1=2	2	
Central Provinces.			
Nagpur	1=4	1	Additions and corrections made to boundaries.
Seoni	1=4	1	Ditto ditto.
Nagpur and Warda	1=2	2	Ditto ditto.
PLANS OF CITIES AND CANTONMENTS.			
Kolhapur	6=1	1	Proofs passed; press order given.
Mooltan	4=1	6	Compiled from the separate village plans; drawing in progress.
MISCELLANEOUS MAPS.			
Nepal boundary along Sarda River	2=1	3	Corrections made to boundaries.
Lansdowne Forest	4=1	2	Fair maps drawn and sent to press for publication. Proofs passed; press order given.
Extension of Calcutta round Panchanogram	4 & 6=1	10	Fair maps completed and sent to press for publication.
Mandalay including country within a radius of ten miles of city	1=1	2	Proofs passed; press order given.
District Katha (Upper Burma).			
Gold mining grants	8=1	...	Fair maps corrected and sent to press. Proofs passed; press order given.
Do. Index	1=1		
District Shwebo.			
Map of coal tract from Letkokbin to Malé	2=1	2	Ditto ditto.
Manœuvre map of Rawalpindi	1=1	2	Proofs passed; press order given.
Ditto Muttra	1=1	2	Ditto ditto.
Ditto Lucknow	1=1	4	Ditto ditto.
Killa Kanika	1=2	1	Ditto ditto.
District Bassein (Lower Burma).			
Jagundain Kwin	2=1	1	Ditto ditto.
INDEX MAPS.			
Jhansi showing Forest Reserves	1=2⅔	1	Proofs passed; press order given.
For Administration Report	Various	4	Drawn and sent to press.
Do. do.	Various	20	Corrected to 1894 and sent to press.
Tracings prepared.			
Tracings of sheets	...	31	
Village plans	...	59	
Maps coloured.			
Maps on various scales	...	182	For Surveyor-General's Office.

DRAWING OFFICE, CALCUTTA.

SECTION II.—*concluded.*

Statement of work.—concld.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Chanda, Seasons 1888—90.	
District Thongwa „ 1886—90.	
Rampur State „ 1889—91.	
Traverse data, etc., supplied.	
District Thongwa along unsurveyed portion, 16 pages	For Deputy Commissioner.
District Pegu along unsurveyed portion, 35 pages .	For Deputy Superintendent of Survey.
District Kheri along Nepal	For Superintendent, Forest Surveys.
Forest doundary of District Gonda . . .	Ditto ditto.
District Mymensingh along Garo Hills . . .	For Deputy Commissioner, Garo Hills.
Faridpur Villages, 45 pages	For Collector.
District Saran, Season 1882-83	For Deputy Superintendent of Survey.
Village traverses, 118 pages	To public officers.
Offsets of District Gorakhpur along Saran, 15 pages .	For Deputy Superintendent of Survey.
Field book of Dinapur Cantonments, 68 pages .	For Collector.
Table of Co-ordinates of District Lalitpur, 41 pages .	For Garhwal Detachment.
Rectangular co-ordinates of pillars on the forest boundaries of Districts Baraich and Gonda from origin of survey	For Superintendent, Forest Survey.
Latitudes and longitudes of Hill Stations in Nagpur .	Ditto ditto.
Triangulation data of Rawalpindi Cantonments .	For Superintendent of Survey.
Values and description of level bench marks in Balasore	For Extra Assistant Superintendent of Survey.
Miscellaneous.	
Prepared one traverse circuit with interior sub-circuit lines enclosing country six miles around Mooltan City, and plotted the same on 4-inch scale for a congregated village map in 6 sheets; also prepared five traverse circuits with 4-inch plots for five groups of villages in Districts Rajshahi, Shahabad, Patna, Saran, and Faridpur for congregated village maps for district officers. Calculated the area of District Chanda separating *malguzari*, forest and *zamindari* portions, and revised the area of District Shahpur according to *tahsils*. Calculated the areas by *parganas* of 5 sheets, Bengal; 11 sheets, North-Western Provinces; 3 sheets, Punjab; and 3 sheets, Bombay. Prepared a statement showing the areas of districts in Burma surveyed by Revenue Survey; also another statement showing the North-Western Provinces districts in which the triple junctions of villages are boundary pillars. Examined by recalculation several local measure tables of Behar districts for reducing acres and decimals of an acre into *bighas, cottahs*, and *dhurs*, and *vice versâ*. Prepared statements for annual report. Checked annual statements received from Executive Officers.	

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1894.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS RECEIVED			MAPS PUBLISHED				
	Up to 30th September 1893.	Added during past 12 months.	Total up to 30th September 1894.	Up to 30th September 1893.	During past 12 months.	Total to 30th September 1894.	Remaining to be published.	
North-Western Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	(*a*) Figures of previous return have been changed to agree with final results.
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601	...	1,601	1,601	...	1,601	...	
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571	...	5,571	5,571	...	5,571	...	
Benares	2,052	...	2,052	2,052	...	2,052	...	
Bijnor	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	701	...	701	...	
Fyzabad	14	...	14	14	...	14	...	
Ghazipur	4,021	...	4,021	4,021	...	4,021	...	
Gorakhpur	8,615	...	8,615	8,615	...	8,615	...	(*b*) These figures are liable to alteration until publication has been completed.
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,583	...	3,583	3,583	...	3,583	...	
Jhansi	1,661	...	1,661	879	777	1,656	5	
Kumaon (Bhabar)	332	...	332	332	...	332	...	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,794	...	3,794	3,794	...	3,794	...	
Rampur State	1,356	...	1,356	1,356	...	1,356	...	(*c*) Exclusive of 16 sheets reprinted.
Tarai	862	...	862	862	...	862	...	
TOTALS	49,990	...	49,990	49,208	777	49,985	5	(*d*) Exclusive of 2 sheets reprinted.
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Amherst	834(*a*)	1,216	2,050(*b*)	349	1,057	1,406	644	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Kyaukse	801	...	801	801	...	801	...	
Mandalay	762(*a*)	9	771(*b*)	172	599	771	...	
Mejktila	...	300	300(*b*)	...	164	164	136	
Mergui	59(*a*)	895	954(*b*)	...	698	698	256	
Prome	847	...	847	847	...	847	...	
Sagaing	...	1,403	1,403(*b*)	...	28	28	1,375	
Tavoy	763	...	763	59	699	758	5	
Thanrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Thongwa	3,749	...	3,749	3,749	...	3,749	...	
TOTALS	21,392	3,823	25,215	19,554	3,245	22,799	2,416	
Bengal.								
Patna and Gaya	3,054	...	3,054	3,054	...	3,054	...	
Puri (Khurda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Muzaffarpur	1	...	1	1	...	1	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
TOTALS	12,544	...	12,544	12,544	...	12,544	...	
Assam.								
Darrang	1,011(*a*)	63	1,074(*b*)	855	205	1,060	14	
Kamrup	2,171(*a*)	47	2,218(*b*)	2,139	70	2,209	9	
Lakhimpur	148(*a*)	198	346(*b*)	34	312(*d*)	346	...	
Nowgong	1,273(*a*)	4	1,277(*b*)	1,265	12	1,277	...	
Sibsagar	1,981(*a*)	69	2,050(*b*)	1,903(*c*)	139(*c*)	2,042	8	
Sylhet	213	...	213	126	42	168	45	
Sylhet (Jaintia)	...	109	109(*b*)	...	8	8	101	
TOTALS	6,797	490	7,287	6,322	788	7,110	177	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTALS	43	...	43	43	...	43	...	
GRAND TOTALS	90,766	4,313	95,079	87,671	4,810	92,481	2,598	

Abstract of work performed during 1893-94.

PROVINCES.	NUMBER OF SHEETS				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	
North-Western Provinces	557	14	780	...	Scale 16 inches=1 mile.
Burma	475	1,128	3,299	3,245	
Assam	693	208	777	...	
TOTALS	3,725	1,350	4,856	3,245	

ENGRAVING OFFICE, CALCUTTA.

Statement showing work performed during the year 1893-94.

SPECIFICATION.	Number of Plates.	Outline, square inches.	Number of letters cut.	Hills, square inches.	REMARKS.
ENGRAVING.					
Atlas of India.					
Scale 1 inch=4 miles.					
Quarter-sheets (new) completed .	8	88	10,091	82	
Ditto in progress .	40	406	99,508	487	
Additions and corrections to published quarter-sheets . . .	28	83	8,125	61	
Additions and corrections to published full sheets . . .	9	103	30,543	229	
General maps	9	477	46,631	...	
Provincial Maps.					
On scale 1 inch=16 miles . .	13	483	31,945	12	
On various scales for Administration Reports	7	24	5,614	22	
District Maps.					
On various scales for Administration Reports	73	413	20,798	83	
Plans	8	2,035	22,331	205	
Index maps	3	...	4,550	...	
Charts	2	...	150	...	
Miscellaneous subjects . .	36	36	22,766	5	
TOTALS .	236	4,150	303,052	1,186	

COPPER-PLATE PRINTING.

Impressions taken	23,586
Proofs pulled	367
Transfers pulled	436
TOTAL .	24,389

STEEL-FACING.

Double elephant plates, steel-faced	14
Ditto, steel-removed	11
Quarter-sheets, steel-faced	55
Ditto, steel-removed	28
Miscellaneous plates, steel-faced	54
Ditto, steel-removed	27
TOTAL .	189

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of COLONEL J. WATERHOUSE, S.C., *Assistant Surveyor-General, Season 1893-94.*

OUT-TURN.—Owing to a falling off in the demands on the office, the work in the Photographic and Drawing Sections shews a decrease from last year, although the out-turn of the lithographic, zincographic and type printing presses and machines is again considerably greater. An abstract of the work done is given in the statements appended.

ORIGINAL SUBJECTS.—The number of original subjects under reproduction during the year has been 6,862, or 1,503 less than last year. The decrease is principally in the cadastral sheets and extra-departmental work; but this was to have been expected, as the rise last year in both these items was exceptional. Five hundred and thirty-eight subjects have been lithographed, 82 being departmental and 456 extra-departmental, against 589 (51 departmental and 538 extra-departmental) of last year. The remaining 6,324 subjects were reproduced by various photographic processes or by zincography, and comprise 945 departmental, 4,673 cadastral, and 706 extra-departmental subjects. Last year the numbers were 1,044 departmental, 5,597 cadastral, and 1,135 extra-departmental.

The actual number of maps received during the year was 7,076, of which 1,100 were departmental, 4,782 cadastral, and 1,194 extra-departmental, while the number completed and despatched was 7,337, of which 1,192 were departmental, 4,825 cadastral and 1,320 extra-departmental.

LITHOGRAPHIC DRAWING SECTION.—The total number of new drawings or additions, etc. made to maps on stone, taken up and completed during the year, was 566, of which 67 were departmental and 499 extra-departmental. Last year 423 subjects were completed, of which 33 were departmental and 390 extra-departmental. The section has remained under the charge of Mr. H. L. Lepage throughout the year, and under his superintendence considerable progress has been made in training the younger draftsmen to work on zinc as well as stone, so that drawings may be transferred to one or the other as most convenient.

LITHOGRAPHIC PRINTING SECTION.—As explained in last year's report, it is still necessary to make some distinction between zinc and stone printing. The number of subjects printed from stone was 436, or 107 less than last year; of these 55 were departmental and 381 extra-departmental, against 33 departmental and 510 extra-departmental of last year, respectively. The number of pulls from stone was 6,03,504, showing an increase of 48,132 over last year. The number of copies printed was 5,61,754, or 54,857 more than last year; of these 1,13,049 copies were coloured, or 46,273 less than last year.

The three machines have been working steadily and most of the printing work is turned out by them, the hand presses being largely employed in the Lithographic Printing Section for proving and getting ready stones or plates for the machines. It is satisfactory to be able to report that a means has been found for printing the sheets of 1-inch squares for the cadastral surveys on hand-made paper in the machine. At first great difficulty was found in using this paper, on account of its tendency to stretch unevenly under the action of the machine which destroyed the accuracy of the squares. Machine made paper was found to be free from this defect, but trials of it have shewn it to be unsuited for the rough treatment the sheets receive in the field. It has been found, however, that by allowing the sheets of hand-made paper to remain in the open air for some hours before use, so as to equalise the tension all over the sheets, the tendency to stretch is removed and the squares can be printed accurately. This arrangement effects a very considerable saving both in time and labour, because one machine can print in a day as many as could formerly be printed in a hand-press in a month. At least two hand presses had to be constantly employed in printing these sheets, and, even with these, there was great delay and difficulty in meeting the demands. Another improvement that has been effected in this section is the printing of maps on calico in the machine without backing the cloth on paper as was formerly done. This will be a very great advantage, should there be large and urgent demands for maps on cloth; but it is of course only applicable to maps in one colour. For colour printing, it would still be necessary to back the cloth, so as to give it the necessary stiffness to permit of the colours registering accurately.

Mr. E. A. LeFranc was in charge of this section during the year, and has made use of his knowledge of zinc printing to train some of the lithographic printers to this work. Many maps have been put on zinc instead of stone, when stones have not been available or when the work was of a trifling character, and, as in many cases, urgently required. During Mr. Deas' absence on furlough, Mr. Ravenscroft was transferred to work one of the large machines, and a native put to work the small machine in his place. This arrangement has answered well; the native minder has carried through the work remarkably well under the superintendence of Sergeant Vandyke, who has had the general superintendence of the machine printing and to whom the improvements in printing the cadastral 1-inch squares and maps on cloth in the machines are mainly due. Two native printers have died during the year, one of whom was an exceptionally good hand, who was being trained for machine printing and promised well: he was a good colour printer both on stone and zinc and will be hard to replace.

ZINC-PRINTING SECTION.—The zinc-printing presses, normal and cadastral, have been under the general superintendence of Mr. B. Mackenzie throughout the year. The

number of zinc plates printed during the year was 1,265, of which 730 were departmental and 535 extra-departmental. The number of pulls was 266,795 (127,695 departmental and 139,100 extra-departmental) and of complete copies 355,009 (139,903 being departmental and 215,106 extra-departmental). Last year the number of plates printed was 1,214 (624 departmental and 590 extra-departmental) pulls 309,287 (109,001 departmental and 200,286 extra-departmental) and copies 349,075 (107,190 departmental and 241,885 extra-departmental). It will be seen from the above that the departmental work has increased, and the extra departmental fallen off, as was also the case last year.

CADASTRAL ZINC-PRINTING SECTION.—Four thousand seven hundred and sixteen plates of cadastral maps of the North-Western Provinces, Burma and Assam were printed off, the number of pulls being 168,772 and of copies 159,142, as against 5,442 plates, 162,023 pulls and 151,213 copies done last year, showing a decrease of 726 plates and an increase of 6,749 pulls and 7,929 copies. The decrease in the number of plates is due to a much larger number of sheets of Burma being printed off and comparatively few North-Western Provinces sheets, the number of copies of the former being more than double that of the latter.

During the month of September trials were made of a new process of chemically cleaning and graining zinc plates in order to save the time and labour of cleaning them by hand with snakestone and graining with sand, and it has since been used with success. The process was invented and patented by Mr. G. H. Block and permission to use it having been acquired by the English Government, the details of it were communicated to this Department through the India Office, and by the kindness of the authorities of the Ordnance Survey Office at Southampton, I was able to see it in use there. The details are as follow:—

The plate on which the old work remains is immersed for ten minutes in a bath of saturated caustic potash, then well washed front and back in water, after which no trace of ink should remain on the plate. (Since my return I have found it an advantage to wash off the old work with turpentine before treating the plate with the potash solution, which is thus kept cleaner and lasts much longer). After removal from the potash bath the surface of the plate is rubbed with pumice stone, but we have found that fine graining sand answers equally well. The plate is next immersed in an acid bath prepared as follows:—

Dissolve 6 lb of alum in 8 quarts of hot water. Then add nitric acid 2 quarts and cold water 12 quarts. This forms a stock solution which is diluted for use with water in the proportion of 8 to 1. The trough containing the solution is gently rocked and the plate is sponged four or five times to remove the coating of oxide formed on the surface. It is then allowed to remain in the bath a few minutes longer, after which it is removed and washed with clean water, and while still moist, sprinkled over with carbonate of magnesia, which is well rubbed into the plate. It is then again washed and dried quickly by pouring boiling water over the back or placing it out in the sun. The preparation of an ordinary plate takes about half an hour, and 30 plates can easily be grained by 6 men in a day, whereas it formerly required 20 men to grain or polish the same number of plates in the same time.

The process has so far only been adopted in the Cadastral Zinc-Printing Section and has been of special use there, because it gives a means of quickly producing a large number of grained plates and thus the use of polished plates, which have hitherto been employed in order to save the labour of graining, but are not so satisfactory, can now be dispensed with. The section has been in charge of Mr. G. A. Lefranc who has given a good deal of attention to the new method of graining.

TYPE-PRINTING SECTION.—The number of items set up was 10,785, against 11,210 of last year. The number of pulls was 1,564,453 and copies 820,605, against 1,418,607 and 693,668 of last year, which again shows an increase in pulls and copies, but a decrease in the number of items received. In order to meet the increased demands and facilitate the work of this section generally, it was found necessary to re-organise the establishment and take on some more hands in the composing room. One good compositor, an impositor, a roller moulder and a boy were taken on. This increase has enabled all arrears to be cleared off and the work to be carried on without the constant strain it was formerly.

NEGATIVE SECTION.—The total number of negatives taken during the year was 5,553, including 35 reversed negatives and 79 transparencies required for the heliogravure process. Of these 1,339 were of departmental maps, etc., 3,418 cadastral and 796 extra-departmental. Last year the numbers were 1,552 departmental, 4,203 cadastral and 1,191 extra-departmental, showing a decrease of 213 departmental, 785 cadastral and 395 extra-departmental, in all 1,393 negatives due to less work coming in generally. The section was in charge of Mr. H. Haward till 24th February, when Mr. J. Harrold took charge and kept it till the end of the year. There have been no changes in the processes, but Mr. Harrold has been able to make some changes in the direction of improved working and economy of chemicals.

PHOTO-TRANSFER PRINTING SECTION.—The number of photo-transfer prints prepared was 5,835, of which 1,523 were departmental, 3,566 cadastral and 746 extra-departmental. Last year the numbers were 1,367 departmental, 3,983 cadastral and 928 extra-departmental, showing an increase of 156 departmental, a decrease of 417 cadastral and 182 extra-departmental, or a total decrease of 443. There have been no changes in the

processes. Mr. R. George was in charge during the time Mr. Harrold held charge of the Negative Section as above.

SILVER PRINTING SECTION.—The number of silver prints made during the year was 1,365, against 1,269 of last year, showing an increase of 90; but on the other hand the number of blue prints taken for proofs and other purposes shows a decrease of 244, the number printed being 2,648 against 2,892 of the year before.

Some experiments were made with the object of finding a method of quickly and cheaply producing silver prints when required in large numbers. The commercial gelatino-chloride and bromide papers now so commonly employed would answer perfectly, but they are comparatively expensive to purchase, do not keep well in this climate, and are difficult to prepare without special appliances for coating the paper evenly with the sensitive emulsion. Trials were therefore made to prepare a gelatino-bromide paper for development printing, by first coating plain photographic paper with a mixture of gelatine and bromide of potassium with a little chrome alum, then after drying, sensitising in the ordinary 60-grain nitrate of silver bath, and after sensitising, washing well with water, to remove all free nitrate of silver, and drying. After exposure the prints were developed with ferrous oxalate. In the first trials a little potassium iodide was added to the salting bath of gelatine, but this was found to fog the image. The formula finally decided on was—

Gelatine	10 grammes.
Potassium bromide	2 „
Chrome alum	1 gramme.
Water	100 c. c.

Some salt was added to the water used for washing the paper after sensitising. This procedure gave fairly good prints and with further practice and experience the process might be found of use. The great difficulty is to secure an even coating of gelatine.

The only other item to be noted is that experience has amply proved the value of soaking albumenised prints in spirits of wine previous to toning as a preventative of blisters. The work of the section has been carried on by Mr. C. J. Meade.

HELIOGRAVURE SECTION.—No variation has been made in the methods of working the various processes, but by extended experience a greater certainty of obtaining the desired result has been attained. Eighty-six plates were prepared by the photo-etching process and 50,678 copies printed during the year, showing an increase of 1 in the number of plates and a decrease of 10,404 in the number of copies as compared with last year. This decrease is accounted for by the fact that last year over 20,000 copies were reprinted from the plates of the "Technical Art Series" of previous years, the demand for these having increased. With this number deducted the printing of plates done during the year would show an increase of about 10,000. The demands for photo-blocks have been very small on account of the difficulty of getting the blocks properly printed in this country and only four have been prepared during the year. In electrotyping, matrices and duplicates of engraved plates 18 were done against 19 in the previous year.

Among the work done during the year were some plates of vertebral bones illustrating a paper by Surgeon-Captain R. H. Charles, M.D. The original negatives were so very dense that many of the details were obscured and several of the plates were also on too small a scale. The density of the original negatives was therefore reduced with a weak solution of perchloride of iron followed by a fixing in weak hyposulphite of soda, which brought out all the details and enabled enlarged transparencies to be taken in the camera, and from these the photo-etchings were made very successfully.

EXPERIMENTAL AND PERSONAL WORK.—From various reasons I have been able to do very little experimental work during the year. In July I was obliged to go to Europe on account of continued ill-health, and while away took the opportunity of visiting the Ordnance Survey Office, Southampton. Colonel Farquharson, C.B., R.E., the Director, and Colonel Johnston, R.E., the Executive Officer, kindly allowed me to see the operations and learn the details of the new direct helio-zincogravure process and also of the zinc-graining process described above. The helio-zincogravure process is likely to be useful, and I am arranging for an early trial of it on some very fine work.

PHOTOGRAPHIC AND

Abstract of Departmental Work

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	*Number of Copies.*		
								Coloured.	Uncoloured.	Total.
Departmental Maps, Plans, etc.										
General Maps	37	20	20	15	49	25	9,255	650	3,655	4,305
Provincial Maps	10	3	3	2	7	5	3,350	550	850	1,400
Divisional Maps	2	8	8	2	4	...	400	...	400	400
District Maps	33	67	67	19	17	7	2,450	...	2,650	2,650
Plans of Cities and Cantonments	324	399	422	97	176	...	10,594	...	10,594	10,594
Standard Maps	327	445	458	154	214	4	28,219	...	28,319	28,319
Index Maps	37	36	35	41	50	7	47,609	45,426	6,210	51,636
Technical Charts	1	2	2	1	2	...	50	...	75	75
Miscellaneous Maps and Plans	223	359	507	174	200	10	35,664	10	39,584	39,594
Transfers and Proofs	...	...	...	...	...	...	2,874	...	...	...
Departmental Forms	33	...	...	...	11	34	221,269	...	213,029	213,029
Type Printing	...	...	...	...	...	...	...	...	...	...
Totals (Normal)	1,027	1,339	1,523	505	730	92	361,734	46,636	305,366	352,002
Cadastral Maps.										
North-Western Provinces—										
Photo-zincographs	819	819	703	721	721	...	9,055	...	9,055	9,055
Zincographs	12	...	...	12	12	...	156	...	156	156
Totals	831	819	703	733	733	...	9,211	...	9,211	9,211
Burma—										
Photo-zincographs	2,072	2,072	2,310	2,156	2,156	...	73,477	...	73,477	73,477
Zincographs	1,061	...	...	1,061	1,061	...	35,856	...	35,856	35,856
Totals	3,133	2,072	2,310	3,217	3,217	...	109,333	...	109,333	109,333
Assam—										
Photo-zincographs	527	527	553	584	584	...	30,952	...	30,952	30,952
Zincographs	182	...	...	182	182	...	9,646	...	9,646	9,646
Totals	709	527	553	766	766	...	40,598	...	40,598	40,598
Transfers and Proofs	...	...	...	...	...	...	9,630	...	...	...
Totals (Cadastral)	4,673	3,418	3,566	4,716	4,716	...	168,772	...	159,142	159,142
GRAND TOTALS (Normal and Cadastral)	5,700	4,817	5,089	5,221	5,446	92	530,506	46,636	464,508	511,144

LITHOGRAPHIC OFFICE.

done during the year 1893-94.

Type Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.		
									R a. p.	
...	...	...	...	...	...	...	...	...	6,989 0 0	
...	...	...	...	...	...	...	...	...	1,754 7 6	
...	...	...	...	...	...	...	...	...	235 0 6	
...	...	...	...	...	...	...	...	...	3,525 8 6	
...	...	...	...	...	...	...	...	...	8,938 9 6	
...	...	...	...	1,588	...	...	...	...	18,595 5 9	
...	...	...	...	146	...	...	...	...	3,618 15 9	
...	...	...	...	...	...	...	...	...	53 1 3	
...	...	...	69	486	3	2,136	...	18	17,063 8 9	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	13,596 9 0	
10,785	1,564,453	820,605	...	...	...	...	...	...	24,390 0 0	
10,785	1,564,453	820,605	69	2,220	3	2,136	...	18	98,760 2 6	
...	...	...	...	...	...	...	...	...	10,917 14 0	
...	...	...	...	...	...	...	...	...	68 10 0	
...	...	...	...	...	...	...	...	...	10,986 8 0	
...	...	...	...	...	...	...	...	...	33,751 4 6	
...	...	...	...	...	...	...	...	...	9,427 12 0	
...	...	...	...	...	...	...	...	...	43,179 0 6	
...	...	...	...	...	...	...	...	...	11,286 4 0	
...	...	...	...	...	...	...	...	...	2,319 10 9	
...	...	...	...	...	...	...	...	...	13,605 14 9	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	67,771 7 3	
10,785	1,564,453	8,20,605	69	2,220	3	2,136	...	18	1,66,531 9 9	

PHOTOGRAPHIC AND

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and: Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.
Adjutant General in India	2	...	6	4	4	3	2,585
Agent and Chief Engineer, Assam-Bengal Railway	57	49	49	26	19	...	1,900
Agent to the Governor-General, Central India and Rajputana	...	...	...	...	1	...	42
Archæological Surveyor, Bombay	...	...	...	...	...	...	...
Architectural Surveyor, North-Western Provinces and Oudh Circle	58	21	101	16	16	...	10,400
Asiatic Society, Bengal	3	6	...	...	...	...	...
Board of Revenue, Bengal	14	...	...	...	2	46	15,980
„ „ North-Western Provinces and Oudh	24	36	12	6	...	...	...
Calcutta, Municipality	3	...	...	...	...	3	1,000
Chief Commissioner, Assam	2	...	...	...	3	...	2,400
„ „ Burma	...	...	...	...	1	1	281
„ „ Central Provinces	...	...	...	...	...	1	400
Chief Engineer, Bengal, Public Works Department	19	45	45	19	19	10	7,990
„ Punjab, Irrigation Works	20	15	15	10	16	2	7,280
„ „ Public Works Department	1	1	1	...	2	...	400
„ Madaripur Railway Extension	1	1	1	4	3	...	160
Colonial Secretary, Straits Settlements	9	14	14	9	...	...	...
Commissioner of Chota Nagpur	...	...	...	1	2	...	210
„ Excise, Bengal	5	...	...	...	4	2	2,400
„ „ Punjab	2	...	...	...	4	...	860
„ Police, Calcutta	...	...	...	...	...	2	2,108
„ Salt Abkari, etc., Madras	...	...	...	...	...	1	450
„ Settlements and Agriculture, Central Provinces	2	2	3	2	1	...	3,500
Commandant, Sardar Rissala, Jodhpur	2	4	4	2	...	...	...
Conservator of Forests, Bengal	...	...	...	...	5	...	70
„ Pegu Circle, Burma	2	3	...	...	...	...	...
Deputy Assistant Adjutant-General, Rawalpindi District	1	2	...	...	...	...	...
Deputy Commissioner, Darrang	...	...	...	...	2	...	300
„ „ Gurgaon	15	...	...	...	...	...	...
„ „ Myaungmya Circle	3	1	1	1	1	...	16
„ „ Sandoway District	...	...	...	...	1	...	15
„ „ Sibsagar	...	...	...	...	...	1	80
„ „ Simla District	1	1	1	1	1	...	100
„ Post Master General, Burma	1	...	...	...	...	2	360
„ „ „ Central Provinces	1	...	...	...	...	2	200
„ Surgeon General „ „	...	...	...	1	1	...	275
Director General, Military Works	39	54	54	22	20	...	1,180
„ „ Post Office	1	...	...	...	...	4	48
„ „ Railways	...	...	...	...	...	...	...
„ „ Telegraphs	12	...	...	...	...	12	5,937
„ Geological Survey, India	27	16	33	...	6	15	6,755
„ of Land Records and Agriculture, Assam	1	...	...	...	5	4	959
„ „ „ „ „ Bengal	1	...	...	...	...	4	1,000
„ „ „ „ „ Gwalior State	...	...	...	...	...	4	10,000
„ Military Education, India	6	1	1	1	1	6	6,600
„ Persian Gulf, Telegraphs	...	...	...	...	9	...	162
„ Public Instruction, Bengal	4	...	...	...	4	...	2,392
„ Royal Indian Marine	8	8	...	...	...	...	...
District Engineer, Muzaffarpur	1	...	...	...	...	3	300
„ Superintendent of Police, Patna	...	...	...	3	3	...	300
Divisional Engineer, Jummu Division	5	...	...	...	...	2	50
Engineer-in-Chief, Cuttack-Midnapur-Calcutta Railway	12	9	9	3	3	9	800
„ Chittagong-Akyab Railway	1	1	1	2	2	...	200
„ Delhi-Minchinabad Railway	1	...	...	...	...	4	600
„ East Coast Railway	12	12	12	4	7	...	500
„ Kalka-Simla Railway	1	6	6	2	2	...	100
„ Ujain-Bhopal Railway	9	9	9	3	4	...	270
„ Umerkot-Pachpadra Railway	1	...	...	2	...	1	50
Engineer to the Sanitary Board, Bengal	16	22	24	13	13	...	2,600
General Officer Commanding Meerut District	1	4	4	4	4	...	440
„ „ „ Punjab Frontier Force	1	...	...	...	...	1	72
„ „ „ Secunderabad District	1	2	2	2	2	...	1,100
„ „ „ Sirhind District	1	2	2	2	3	...	300
Carried over	410	347	410	165	196	145	104,477

LITHOGRAPHIC OFFICE.

Departments, etc., during the year 1893-94.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.		
Number of copies.											
Coloured.	Uncoloured.	Total.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo. blocks.	Electrotypes.	£	a.	p.
...	2,630	2,630	...	...	...	...	...	...	272	10	6
...	3,500	3,500	...	...	...	...	...	...	1,216	14	9
...	42	42	...	...	...	...	...	...	15	12	0
...	...	...	23	...	...	...	...	...	17	4	0
...	41,600	41,600	...	39	1	2,601	...	...	2,869	15	6
...	...	...	...	...	7	2,966	...	...	461	1	6
8,880	840	9,720	...	...	...	...	...	...	1,508	13	0
...	...	...	...	216	...	...	...	...	596	11	3
800	200	1,000	...	...	...	...	...	...	141	9	6
...	4,400	4,400	...	...	...	...	...	...	230	13	3
...	281	281	...	...	...	...	...	...	71	7	6
...	400	400	...	...	...	...	...	...	31	10	0
1,815	3,040	4,855	...	...	...	...	...	...	1,681	7	6
250	9,550	9,800	...	...	...	...	...	...	885	11	9
...	400	400	...	...	...	...	...	...	119	15	6
...	160	160	...	...	...	...	...	...	40	10	6
...	...	...	...	...	...	...	...	...	246	9	6
...	210	210	...	...	...	...	...	...	32	0	0
2,000	...	2,000	...	...	...	...	...	...	258	2	0
430	...	430	...	...	...	...	...	...	82	6	0
1,054	...	1,054	...	...	...	...	...	...	125	7	0
...	450	450	...	...	...	...	...	...	69	0	0
...	3,500	3,500	...	...	...	...	...	...	283	9	6
...	...	...	...	...	...	...	...	...	69	9	6
...	70	70	...	...	...	...	...	...	67	6	9
...	...	...	...	6	...	...	...	...	31	3	3
...	...	...	...	30	...	...	...	...	87	9	9
...	300	300	...	...	...	...	...	...	100	5	0
...	...	...	...	...	...	...	...	...	594	0	0
...	16	16	...	3	...	...	...	...	33	14	6
...	15	15	...	...	...	...	...	...	7	2	0
...	80	80	...	...	...	...	...	...	20	0	0
...	100	100	...	...	...	...	...	...	33	9	0
...	180	180	...	...	...	...	...	...	553	1	0
...	100	100	...	...	...	...	...	...	278	1	0
...	275	275	...	...	...	...	...	...	45	11	0
...	3,945	3,945	...	...	...	...	...	...	1,078	14	6
48	...	48	...	...	...	40	...	...	67	6	0
...	...	...	...	...	7	708	...	...	525	0	0
...	7,934	7,934	...	...	...	...	...	...	946	12	0
1,470	1,585	3,055	...	...	3	2,103	...	...	1,478	2	9
...	959	959	...	...	...	...	...	...	290	9	6
250	...	250	...	...	...	...	...	...	74	6	0
...	32,500	32,500	...	...	...	...	...	...	397	13	0
4,000	600	4,600	...	...	...	...	...	...	685	0	6
...	90	90	...	...	...	...	...	...	106	11	6
2,392	...	2,392	...	...	...	...	...	...	132	13	0
...	...	...	2	...	8	8	...	...	482	11	3
100	...	100	...	...	...	...	...	...	200	0	0
...	600	600	...	...	...	...	...	...	118	5	0
...	125	125	...	...	...	...	...	...	37	3	0
80	880	960	...	...	...	...	...	...	574	11	6
...	100	100	...	...	...	...	...	...	33	9	6
300	...	300	...	...	...	...	...	...	112	8	0
...	1,635	1,635	...	...	...	...	...	...	265	13	3
...	100	100	...	...	...	...	...	...	109	14	3
...	810	810	...	...	...	...	...	...	177	11	6
...	50	50	...	...	...	...	...	...	50	1	0
...	3,400	3,400	...	...	...	...	...	...	700	2	9
...	220	220	...	...	...	...	...	...	179	7	6
...	72	72	...	...	...	...	...	...	196	5	0
...	550	550	...	...	...	...	...	...	229	2	9
...	300	300	...	...	...	...	...	...	118	9	3
23,869	128,794	152,663	25	294	26	8,426	...	...	22,550	15	0

PHOTOGRAPHIC AND

Statement of work done for other

Departments, etc.	Sheets or subjects.	Nagatives and transparencies.	Photo-zincographic and				
			Photo-transfer prints	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.
Brought forward	410	347	410	165	196	145	104,477
Government of India, Revenue and Agriculture Department	117	74	15	10	19	22	65,987
Government of India, Foreign Department	30	23	23	17	32	9	1,638
„ Home Department	7	...	...	...	...	1	40
„ Marine Department	2	2	2	1	1	2	75
„ Military Department	10	4	4	3	3	3	212
„ Public Works Department	107	140	136	74	111	25	56,706
Government of Bengal, Revenue and General Department	4	2	2	...	...	4	28,446
„ Financial Department	7	...	...	...	4	1	3,712
„ Judicial and Political Department	3	...	...	...	4	...	2,674
„ Legislative Department	1	...	...	...	1	...	200
„ Marine Department	9	...	...	...	...	4	2,000
„ Public Works Department, Irrigation	4	9	9	6	7	6	4,916
Government of Madras, Archæological Department	14	2	...	...	...	3	1,950
Government of North-Western Provinces and Oudh, Public Works Department	26	24	24	13	24	7	8,260
Government of Punjab, Public Works Department	2	8	8	2	6	2	2,505
„ Revenue Department	2	...	...	...	...	2	500
Government Epigraphist, Madras	5	4	14	6	5	...	3,315
Indian Museum	26	38	...	...	...	1	420
Inspector General of Artillery, India	35	8	8	2	6	3	2,325
„ Civil Veterinary Department	2	...	...	...	...	5	1,150
„ Jails, Bengal	7	...	...	...	8	...	300
„ Ordnance	18	4	4	...	...	8	2,560
„ Police, Bengal	6	...	...	2	2	4	1,940
Manager, Eastern Bengal State Railway	5	2	2	1	2	3	500
Meteorological Reporter, India	49	2	...	...	6	22	78,675
„ Bengal	4	...	...	...	2	6	37,472
Officer Commanding No. 4 Hazara Mountain Battery	...	...	...	...	...	...	...
Photographic Society, India	6	4	...	...	...	1	1,000
Port Commissioners, Calcutta	1	4	4	1	...	...	...
Port Officer and Registrar of Wrecks	1	...	...	...	...	2	24
Post Master General, Bengal	...	...	...	...	12	...	1,800
„ North-Western Provinces	...	...	...	3	...	...	...
„ Punjab	1	...	...	...	...	6	1,050
Principal, Civil Engineering College, Sibpur	...	...	...	...	...	...	...
Private Secretary to His Honour the Lieutenant Governor, North-Western Provinces and Oudh	1	...	...	...	...	2	100
Quarter-Master General, India	44	27	27	16	36	13	7,596
Reporter on Economic Products, Government of India	...	...	...	...	...	...	...
Resident Engineer, Benares Sewerage and Water Works	1	1	1	1	1	...	200
Sanitary Commissioner, Assam	1	...	...	...	...	1	300
„ Bengal	6	...	...	...	...	9	6,300
„ India	3	2	...	...	...	4	2,750
„ Hyderabad Assigned Districts	1	...	...	...	...	3	600
Secretary for Berar to the Resident at Hyderabad	...	...	...	...	1	...	194
„ Cart Competition Committee	5	...	...	...	...	...	...
„ to His Highness the Nizam's Government	16	16	16	6	...	...	...
„ Lady Dufferin's Fund	...	...	...	...	...	2	3,000
„ Royal Opium Commission	6	4	4	2	8	...	15,350
„ Hemp Drugs Commission	24	...	...	...	...	2	3,040
Settlement Officer, Kanika	1	1	...	...	...	...	...
Superintendent, Government Press, North-Western Provinces and Oudh	1	...	...	1	1	3	1,515
Superintendent, Government Printing, India	92	15	13	5	17	45	35,290
„ of Emigration	2	...	...	...	...	6	24
„ of Stationery	...	...	...	...	4	4	3,816
Traffic Superintendent, Eastern Bengal State Railway	1	...	...	...	2	...	4,000
Special work done for Trade and Private Individuals	30	29	20	17	14	3	7,661
Totals	1,162	796	746	354	535	394	508,565

LITHOGRAPHIC OFFICE.

Departments, etc. during the year 1893-94—contd.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.		
Number of copies.											
Coloured.	Uncoloured.	Total.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.	*R.*	*a.*	*p.*
23,869	128,794	152,663	25	294	26	8,426			22,550	15	0
24,194	11,621	35,815	...	70	37	18,212	3	...	9,831	15	9
130	2,207	2,337	...	...	...	...	...	...	1,160	3	9
...	280	280	...	...	...	...	...	...	99	0	0
25	25	50	...	...	...	...	...	...	115	12	9
...	421	421	...	...	...	...	...	...	148	5	6
8,576	50,729	59,305	...	...	...	...	...	...	9,067	9	6
20,826	...	20,826	...	...	...	...	...	...	1,139	2	3
909	8,000	8,909	...	...	...	...	...	...	355	12	0
...	3,462	3,462	...	...	...	...	...	...	303	5	3
...	200	200	...	...	...	...	...	...	33	8	0
4,500	...	4,500	...	...	...	...	...	...	187	5	0
1,460	536	1,996	...	...	...	...	...	...	496	2	0
...	7,800	7,800	...	...	2	2,862	...	...	883	4	0
...	12,540	12,540	...	...	...	...	...	...	2,063	11	6
...	4,505	4,505	...	...	...	...	...	...	444	12	9
500	...	500	...	...	...	...	...	...	73	4	0
...	5,935	5,935	...	...	...	...	...	...	456	4	6
...	420	420	...	4	12	5,014	...	...	1,349	1	6
...	9,225	9,225	...	...	...	...	...	...	664	12	6
200	550	750	...	...	...	...	...	...	465	10	0
...	275	275	...	...	...	...	...	...	370	9	0
...	4,480	4,480	...	...	...	...	...	...	601	14	0
1,740	300	2,040	...	...	...	...	...	...	225	14	6
...	500	500	...	...	...	...	...	...	490	11	0
7,025	98,175	105,200	...	20	...	...	...	...	3,221	5	3
16	37,440	37,456	...	...	...	...	...	...	526	8	0
...	...	...	1	...	...	...	...	...	1	5	6
...	1,000	1,000	...	...	4	6,006	1	...	477	0	0
...	...	...	...	...	...	...	...	...	57	9	6
...	24	24	...	...	...	...	...	...	48	7	0
...	1,800	1,800	...	...	...	...	...	...	550	8	9
...	...	...	...	...	...	...	...	...	16	3	3
...	175	175	...	...	...	...	...	...	683	10	0
...	...	...	...	...	...	120	...	...	18	0	0
50	...	50	...	...	...	...	...	...	100	11	0
375	7,846	8,221	...	...	...	...	...	...	2,993	13	6
...	...	..	...	...	...	4,750	...	...	570	0	0
...	200	200	...	...	...	...	...	...	37	1	0
...	300	300	...	...	...	...	...	...	77	8	0
3,500	700	4,200	...	...	...	...	...	...	429	0	0
800	1,500	2,300	...	...	2	3,152	...	...	808	6	0
200	...	200	...	...	...	...	...	...	37	15	0
...	387	387	...	...	...	...	...	...	11	3	9
...	...	...	...	...	...	...	...	...	50	0	0
...	...	...	...	...	...	...	...	...	219	0	0
1,500	...	1,500	...	...	...	...	...	...	95	0	0
12,280	...	12,280	...	6	...	...	...	...	975	6	0
...	1,520	1,520	1,264	...	...	...	...	...	871	15	6
...	...	...	...	6	...	...	...	...	14	1	6
350	815	1,165	...	...	...	...	...	...	147	14	6
6,195	26,936	33,131	...	16	...	...	...	...	2,887	7	3
16	...	16	...	...	...	...	...	...	120	9	0
...	3,816	3,816	...	...	...	...	...	...	223	8	0
2,000	...	2,000	...	...	...	...	...	...	304	10	0
125	7,961	8,086	6	12	...	...	...	...	987	1	0
121,361	443,400	564,761	1,296	428	83	48,542	4	...	71,141	10	3

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Details of Issues to and Receipts from Provinces and Departments during the financial year 1893-94.

PROVINCES AND DEPARTMENTS.	VALUE OF			
	Receipts.	Issues.	Debits.	Credits.
	₹	₹	₹	₹
Assam	2,829	6,811	3,982	...
Bengal, Civil	12,283	27,799	15,516	...
„ (East) Military	940	2,782	1,842	...
„ (West) „	5,050	8,494	3,444	...
Berar	92	549	457	...
Bombay, Civil	3,199	2,376	...	823
„ Military	175	3,725	3,550	...
Burma	6,821	36,886	30,065	...
Central India	...	356	356	...
Central Provinces	48	7,308	7,260	...
Forests	...	1,338	1,338	...
Geological Survey and Museums	...	423	423	...
Guaranteed Rys., East Indian Railway	42	...	...	42
Hyderabad, P. W. D.	...	81	81	...
Khorasan	32	...	...	32
Madras, Civil	6,810	5,365	...	1,445
„ Military	2,547	2,753	206	...
Marine	184	1,813	1,629	...
Meteorological	187	907	720	...
Mint	895	...	...	895
N.-W. Provinces and Oudh	3,741	1,443	...	2,298
P. W. D., N.-W. State Railway	2,885	477	...	2,408
„ Military Works	3,064	4,072	1,008	...
„ Baluchistan, Railway Branch	14	6,863	6,849	...
Political	448	596	148	...
„ Special Afghan Boundary Demarcation	...	403	403	...
Punjab	7,523	22,111	14,588	...
Rajputana and Central India	833	573	...	260
Survey Department, Field Parties	23,136	68,733	45,597	...
„ „ Head-quarters Offices	5,664	4,281	...	1,383
Telegraph	...	132	132	...
TOTALS	89,442	2,19,450	1,39,594	9,586
NET DEBIT	...	...	1,30,008	...
CASH SALES	...	...	38,037	...
GRAND TOTAL	...	...	1,68,045	...

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1893-94.

SPECIFICATION.	Number.	Value.
		£ a.
Instruments.		
Anemometers, Robinson's	5	400 0
Barometer, aneroid, ordinary, 4½-inch	2	160 0
Chains, measuring, iron, 66 feet	500	1,800 0
Chains of sorts and sizes	150	375 0
Chronographs, watch pattern	15	440 0
Clinometers, survey pattern	24	348 0
,, Watkins' pattern	2	59 8
Clocks	3	45 0
Compass, bow, ink, electrum, single jointed	25	51 9
,, ,, ,, ,, double ,,	1	6 0
,, ,, ,, ,, spring	98	128 10
,, ,, pencil brass, single jointed	2	0 8
,, ,, ,, electrum, single jointed	26	50 7
,, ,, ,, ,, double ,,	1	6 0
,, ,, sets spring	1	9 3
,, drawing, ordinary brass, 5-inch	418	454 6
,, ,, ,, electrum, 6-inch	48	96 0
,, ,, hair electrum, 5-inch	11	46 12
,, magnetic, rectangular, 2-inch and 2½-inch	18	108 0
,, ,, ,, 5-inch	173	2 107 8
,, ,, ,, 6-inch	188	2,328 0
,, Napier's	2	22 15
,, pillar	1	13 5
,, prismatic, silver ring, 4-inch	8	840 0
,, ,, ,, ,, 4½-inch	3	260 0
,, proportional, brass, 9-inch	1	18 11
,, ,, electrum, 6-inch	1	18 6
,, ,, ,, 9-inch and 12-inch	3	73 8
Covers for plane tables	48	198 12
Glasses, binocular, small	6	270 0
Instruments, drawing, mathematical, brass, 1st sort	2	137 11
,, ,, ,, ,, 2nd ,,	1	46 0
,, ,, ,, ,, 3rd ,,	9	172 0
,, ,, ,, electrum, 1st sort, with needle points	1	73 0
,, ,, ,, ,, 2nd ,,	11	440 4
,, ,, ,, Addiscombe and Royal Engineer pattern	6	202 14
Levels, reflecting, Abney's	5	138 12
,, spirit, in wooden case, 16-inch and others	12	24 0
Machines, map printing, Gastrell's pattern	3	172 8
,, ,, ,, Ordnance ,,	12	510 0
Opiesometers	1	8 12
Pens, drawing, ivory handles	13	49 9
,, dotting	1	4 0
,, double or road	1	3 12
Pins for chains, ordinary	4,000	250 0
,, ,, maps, brass	864	54 0
Plane tables, deal, survey pattern	355	2,488 8
Planimeter, electrum	2	133 4
Protractors, brass, semi-circular, plain	3	1 8
Pluviometer, Symon's, 5-inch	27	162 8
Rods, measuring	2	6 0
Rings, silver, for prismatic compass	18	230 10
Rules, folding ivory, 2-feet, 4-fold	1	16 10
,, parallel, bar electrum	1	55 0
,, ,, ,, ivory	1	2 4
Carried forward	7,136	16,119 6

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1893-94—contd.

SPECIFICATION.	Number.	Value.
Instruments—contd.		R a.
Brought forward .	7,136	16,119 6
Rules, parallel, bar, wooden, 6-inch	136	102 0
,, ,, ,, ,, 2 feet to 3 feet	3	49 11
,, ,, on rollers, brass, 6-inch and 9-inch . . .	1	30 0
,, sight, wooden	577	1,732 8
Scales, diagonal, metal, 2-inch to the mile	22	87 8
,, ,, wooden	744	348 12
,, offsets, single, ivory	1,500	562 8
,, plotting sets, wooden	2	25 4
,, plotting, single, wooden	3	0 15
Sectors, ivory, 6-inch	1	3 10
,, wooden, 6-inch	1	1 5
Set squares, single, ebonite	2	1 0
Sheets, celluloid	600	150 0
Squares, optical	887	5,768 12
Stands for prismatic compasses	3	60 0
,, ,, plane tables, survey pattern	747	5,232 8
,, ,, ,, military ,, ...	12	216 0
Staves, levelling, Roorkee, single	15	198 0
Stencil plates, various	36	64 8
Tapes, steel, 50 feet	6	57 0
,, ,, 100 ,, ...	1	20 0
Telescopes, spare, for range finder	6	71 4
Thermometers, common, in tin cases	55	116 4
,, minimum, self-registering	10	133 12
,, solar radiation, black bulb, in air . . .	2	57 10
,, terrestrial radiation	2	33 10
T. squares, wooden	3	6 4
Umbrellas, surveying	71	1,058 10
TOTALS .	12,584	32,308 9
Books.		
Manual of Surveying	5	60 0
Nautical Almanac	100	176 10
Practical Physics	1	5 10
Tables, Log, Chamber's	36	110 4
,, ,, Shortredes, with sines, etc.	12	244 13
Regulations for use of Watkins' Artillery Telemeters and Metrometers	6	4 11
Tables, Traverse, Gurdens	8	114 12
Bruhn's Manual of Logarithms	12	49 0
Indian Patentee's Guide	1	3 8
TOTALS .	181	769 4
Sundries.		
Brass plate screws for plane tables	100	325 0
Brushes, stencil	12	6 0
,, ,, medium size	22	11 0
Standard weights from ·01 grain to 600 grains	3	49 0
Thermometer, oven	1	50 14
Rules, carpenters', with brass sliding scale	1	2 0
Scales, balance and weights	1	40 2
,, for weighing letters	2	21 2
,, ,, parcels	1	15 8
Carried forward .	143	520 10

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1893-94—concld.

SPECIFICATION.	Number.	Value.
		₹ a.
Sundries—contd.		
Brought forward .	143	520 10
Frames and fittings for staves	50	475 0
Brass plates with screws for plane tables	250	825 0
No. 2 small Roman type, sets	1	24 0
Stencil ink, red	6	4 8
Plumbago crucibles	24	10 0
Brass rod, ⅜-inch and ½-inch	12½	7 13
Steel wire	4	2 0
Zinc tickets	100	6 0
Numbers for chains	200	6 4
Handles, brass, for chains	80	25 0
Brass weights for parcels	1	9 8
Double pillar wrench, 12-inch and 14-inch	2	11 9
Stencil ink (red and black), tins	9	5 4
Tape for Weldon's range finder	1	8 4
Stocks and dies, etc.	3	48 8
TOTALS .	886½	1,989 4
TOTAL OF BOOKS . .	181	769 4
„ OF INSTRUMENTS .	12,584	32,308 9
GRAND TOTAL .	13,651½	35,067 1

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1893-94.

SPECIFICATION.	Number.	Value. £	a.
Instruments.			
Bars, standard, steel	3	75	0
Boards, drawing, deal	53	579	0
Cases, leather and Morocco, spare	4	14	0
Celluloid, sheets	445	239	4
Chains, measuring, iron, 30 feet	111	287	8
„ „ „ 33 „	100	250	0
„ „ „ 66 „	1,668	5,888	0
„ „ „ 100 „	100	700	0
„ „ steel	68	739	0
„ „ of sorts and sizes	356	899	8
Clinometers, survey pattern	39	1,245	0
Combs, acre, cardboard	3,230	1,040	10
Compasses, magnetic, rectangular, 5-inch	155	2,015	0
„ „ „ 6-inch	193	2,868	0
Covers for plane tables	14	70	0
Glasses, copying or tracing	3	120	0
Heliotropes, 6-inch	6	300	0
Lamps, bull's-eye	9	45	0
„ referring	22	112	0
Levels, field service	4	128	0
Machines, map printing, Ordnance pattern	10	425	0
Pins for chains, ordinary	5,020	315	0
Plane tables, deal, survey	755	5,208	0
„ „ „ military	18	54	0
„ „ teak and others	3	21	0
Plates, graticule	1	32	0
Protractors, cardboard, 9-inch and 12-inch	100	125	0
Pluviometers, Symon's, 5-inch	281	1,755	0
Rods, measuring	12	21	0
Rules, flat, wooden, plain, 12-inch and 18-inch	407	81	4
„ sight, brass	24	240	0
„ „ wooden	36	216	0
Scales, diagonal, cardboard	6,100	1,550	0
„ „ metal, 2-inch to the mile	395	1,580	0
„ horn	190	113	4
„ offsets, single, ivory	74	32	4
„ „ „ wooden	61	14	15
„ horn sheets	20	20	0
„ plotting, single, metal	15	112	8
„ offsets „ cardboard	200	50	0
Squares, optical	115	747	8
Stamps for conventional signs	2	5	0
Stands for clinometers	12	30	0
„ „ heliotropes	39	624	0
„ „ plane tables, survey pattern	176	1,232	0
„ „ „ military „	12	240	0
„ „ telescopes, metal	2	72	0
Staves, cross or offsets	6	30	0
„ levelling, Gravatt's	12	240	0
„ „ Roorkee, double	5	120	0
„ „ „ single	16	2,366	0
„ „ Sopwith's telescopic	50	1,250	0
Stencil plates, various	185	387	10
Thermometers, chemical	4	30	0
TOTALS	21,094	36,955	3

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1893-94—contd.

SPECIFICATION.	Number.	Value.	
Sundries.		£	*a.*
Boxes, tin	5	15	0
Horn centres	24	3	0
Plummets, brass	18	54	0
Screw, brass, for plane tables	12	18	0
Anthropological instruments, brass	2	10	0
Back boards for barometer	5	55	0
Box, wooden, for stocks and dies	1	5	0
Compass, sub-dividing	1	32	0
Conventional signs	24	6	0
Clamps for staves	6	7	8
Field-writing tables	50	100	0
Funnels for raingauges	6	21	0
Gauges, electrum, for pluviometer	50	112	8
Gauge, Massey's cloth	1	6	0
Nuts and screws for plane tables	8	6	8
Plane table, miiitary pattern, with stand, compass and sight rule, etc.	1	60	0
Plates, brass, for plane tables	12	24	0
Scales, electrum, Vernier	1	16	0
,, metal, brass	1	10	0
Sight vanes for heliotropes	8	40	0
Tin tubes	11	19	4
Trestles, for drawing board	4	26	0
TOTALS	251	646	12
TOTAL OF INSTRUMENTS	21,094	36,955	3
GRAND TOTAL	21,345	37,601	15

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of Principal Instruments repaired in Workshop during the financial year 1893-44.

Specification.	Number.
Anemograph	1
Anemometers	13
Arithmometer	1
Bar, lengthening	1
Barometers, of sorts	70
Boards, drawing	2
„ sketching	1
Camera	1
Chains, of sorts	78
Chronographs	7
Chronometer	1
Chrono-micrometer	1
Clinometers	54
Clocks	11
Compass, Azimuth	1
„ beam, of sorts	2
„ bow dividers	7
„ „ pen, of sorts	85
„ „ pencil „	6
„ drawing, of sorts	141
„ hair, of sorts	5
„ magnetic pocket	7
„ „ for theodolite	2
„ miners	9
„ Napier's	1
„ pilorus	2
„ prismatic, of sorts	113
„ proportional	10
„ rectangular, of sorts	29
„ surveying, of sorts	24
„ with moveable points	1
Field glass	1
Glasses, binocular, of sorts	30
Heliographs	23
Heliotropes	4
Horizon, artificial	1
Horse testing machine	1
Hydrometers	52
Hygrometer	1
Instruments, drawing, mathematical, of sorts	79
Lamps, of sorts	2
Lens	1
Levels, of sorts	129
„ reflecting, Abney's	2
„ spirit	7
Log, Massey's patent	1
Magazine instrument box	1
Microscopes	7
Meters, current	2
Miner's dial	1
Pen, double, or road	1
„ dotting, with wheels	2
„ drawing, of sorts	218
„ leg, of sorts	4
Pencil leg	1
Pentagraphs	3
Plane tables, of sorts	31
Planimeters, of sorts	14
Carried forward	1,306

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of Principal Instruments repaired in Workshop during the financial year 1893-94—contd.

SPECIFICATION.	Number.
Brought forward	1,306
Pins for chains	61
,, ,, maps	18
Pointers, station	2
Protractors, of sorts	4
Pyrometers	2
Quintants, sounding	11
Range finders, of sorts	19
Rain gauges, of sorts	4
Rules, of sorts	52
,, sight, of sorts	95
,, straight edges, of sorts	3
Scales, of sorts	62
Scott's sight, telescopic	22
Sextants, of sorts	21
Squares, optical	151
Stands for compasses, of sorts	50
,, ,, heliographs	7
,, ,, heliotropes	2
,, ,, levels of sorts	61
,, ,, plane tables	42
,, ,, telescopes	1
,, ,, theodolites	56
Staves, levelling, of sorts	101
Tapes, of sorts	368
Telemeters	17
Telescopes, of sorts	125
Theodolites, of sorts	94
Thermometers, of sorts	42
Type-holder	1
Type-writers, of sorts	10
Watches, of sorts	13
TOTAL OF PRINCIPAL INSTRUMENTS	2,823
,, ,, MINOR INSTRUMENTS UNSPECIFIED	1,118
TOTAL OF ALL INSTRUMENTS REPAIRED	3,941

MATHEMATICAL INSTRUMENT OFFICE.

Profit and Loss Account of the Workshop for the financial year 1893-94.

Debits.	R	a.	Credits.	R	a.
To Workshop establishment (less proportion debitable to the Store Branch for cleaning and adjustment of serviceable instruments) .	36,400	15	By Repairs for public officers on book debit ₹8,755 8		
„ One-third of office establishment . . .	2,482	14	„ Repairs for public officers on payment . ₹7,736 5		
„ Pay of Material Storekeeper for the whole year.	780	0		16,491	13
„ Workshop contingencies, as distinguished from materials purchased . .	2,477	8	„ repairs for stock . .	31,477	2
„ Value of materials:—			„ Manufactures for stock:—		
For ordinary work .			instruments . .	36,184	15
„ general workshop use .	24,645	10	packing cases . .	1,728	8
„ manufacture of packing cases .			„ manufacture of materials	3,083	12
„ Paid for repairs . .	48	8			
„ Wear and tear of plant .	1,509	12			
„ Half of rent at ₹600 per mensem . . .	3,600	0			
„ Printing and stationery .	483	5			
„ Four per cent. on value of tools and plant amounting to ₹98,511 . . .	3,940	7			
„ Half of taxes, rates, etc. .	877	0			
„ Liability for pensions .	3,948	0			
„ Profit	7,772	3			
Total .	88,966	2	Total .	88,966	2

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extract from the Narrative Report of MR J. ECCLES, M.A., *Deputy Superintendent, 2nd grade, in charge Computing Party, Season 1893-94.*

During the year the office entered on a new stage of its existence. It was mentioned in the last report that the Photo-zincographic Section was found totally unable to cope with the rapidly increasing amount of work which it was called upon to undertake, and that the Government had been addressed with a view of largely increasing the efficiency of the section. While entirely agreeing as to the need of this increase the Government did not see their way to increasing the permanent grant of the Trigonometrical Branch Office, and it was therefore necessary to devise a scheme whereby the Photo-zincographic Section should be increased at the expense of the other sections The temporary grants for extra computers ceased with the beginning of the financial year, and the new scheme provides for an annual permanent expenditure of R51,558, and a temporary grant for three years of R3,204 per annum, as it was found impossible to curtail the expenses within the amount of the permanent grant all at once.

The amount of the permanent grant is to be divided among the sections as follows:—

	R	
(1) Computing Section	13,404	Per annum.
(2) Printing Section	6,696	
(3) Photo-zincographic Section	16,080	
(4) Correspondence Section	5,232	
(5) Stores, Workshops and Observatories Section	2,724	
(6) Drawing Section	5,316	
(7) Solar Photographic Section	2,106	

while the temporary grant at present includes the pay of a zincographer on R250 per mensem and a writer on R17 per mensem, but it is intended that, at the end of the three years, the zincographer's post shall be made permanent by the transfer of the same amount of money from the Printing Section to the Photo zincographic Section on the retirement of the Head Printer.

The Government further sanctioned the expenditure of R10,000 in altering the office buildings so as to meet future requirements, and the matter is at present in the hands of the Public Works Department.

The reduction in the strength of the other sections necessitated the retirement of Babu Kali Mohan Ghose, whose loss will be greatly felt in the office, and of Babu Kali Kumar Chatterjee from the Computing Section, and of Babus Nurbir Singh, Gopal Chunder Nath, Nabi Buksh, Sahib Singh, Mohamed Shafi and Daya Ram in the Printing Section. During the year, Babu Tarapodo Mukarjee, computer, retired and Babu Har Gopal, computer, and Nur Mohamed, Assistant Draftsman, resigned.

It also led to the following transfers:—

Babu Mizaji Lall from the Computing Section to the Photo-zinco Section.

Babu Mohan Lall and Babu Protab Chand from the Drawing Section to the Photo-zinco Section.

The cost of the Computing Section under its various class heads and their percentages, together with those of the preceding years, are given in the following statement:—

CLASS.	COST IN RUPEES.	PERCENTAGE OF COST.			
	1893-94.	1893-94.	1892-93.	1891-92.	1890-91.
	R				
1. Records, Library	544	1·4	2·6	3	3
2. Accounts, Returns, Correspondence	2,733	7·1	5·4	4	5
3. Supply of data, etc.	1,147	3·0	2·3	3	1
4. Computations	5,019	78·6	79·5	79	74
5. Preparation of Press copy	17,562				
6. Examination of Press proofs	7,762				
7. Ditto of charts	235	0 6	1·5	2	4
8. Protection of stations	452	1·2	1·2	1	1
9. Miscellaneous	2,391	6·2	6·2	6	9
10. Meteorology, etc.	519	1·3	1·1	1⅔	2
11. Extra departmental work	232	0·6	0 1	⅓	1
TOTAL	38,626	100	100	100	100

From this it will be seen that the working power of this section has been distributed much in the same way as in preceding years. Class 2 shows a slight increase on account of extra work in connection with the preparation of special indents, establishment returns, and pension rolls, consequent on the reorganization of the office: the cost of binding some of our publications is also included in this class.

The following is an account of the work done under the several classes shown in the foregoing table :—

CLASS 1.—RECORDS, LIBRARY, ETC.—Seven fresh instalments of field records were received during the year ; these, together with the great mass already stored in the office, have received the usual care and attention.

The three standard copies of the library catalogue have been kept up to date.

CLASS 2.—ACCOUNTS, RETURNS, AND CORRESPONDENCE.—This includes the preparation of indents, estimates, monthly detailed and abstract progress reports, annual report, stock returns of office stores, and various other items.

CLASS 3.—SUPPLY OF DATA.—The demand for this was heavier than usual, twenty-two requisitions of various kinds have been met ; the work connected with the despatch of maps, charts, books, and forms is also included under this head, excepting for the period, 10th July to 30th September, during which the despatch of maps and charts was made by the Photo-zinco section.

CLASS 4.—COMPUTATIONS.—These will be found detailed below ; they mostly appertain to the secondary work of the North-east Longitudinal Series. The progress made is as follows :—

Of the 61 original angle books of the North-east Longitudinal Series, only 19 were found examined and completed by the field parties, the examination of the field-books and the completion of the abstracts of the remainder were taken up at intervals, as the computers' services became available from other urgent work. About 20 angle books were disposed of, and some progress has also been made in the selecting of points and transcribing their data into the triangle sheets.

Revenue Survey Levels in Lower Burma.—The examination and reduction to the most recent determination of sea level has been in hand, about one-third stands reduced.

Palwal Town and Municipality Survey.—The examination of field-books and the computation of the following were completed :—

4 main circuits.
21 sub-circuits.
28 traverses.
24 deductions of observed azimuths.

The rest of the work of this class was of miscellaneous character.

CLASS 5.—PREPARATION OF PRESS COPY.—This entails abstracting and compiling the final results of the various calculations in a suitable form for publication ; all such compilations are twice compared, once against the original field records and once against the final calculations, prior to being sent to the press.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This requires the utmost care in comparison and examination in the several stages of first, second, and form proofs. Most of the matter printed is numerical, or depending on numerical data ; hence it necessarily involves a strictly critical examination, which can only be given by men specially trained to this style of work.

The printing of the following works has been completed during the year :—

(1) Synoptical Volume XXXIV.
(2) Spirit levelled heights No. 1 Burma.
(3) Imperial forest school calendar.

No. (1) requires only the charts, after which it will be put in the hands of the binder, and No. (2) is practically ready for the binder.

During the year Professional Volume XV, Synoptical Volume XXXIII and the catalogue of stars for the epoch 1892 were issued to their several recipients in various parts of the globe.

The details of the work done are as follows :—

(*a*) *Southern Trigon.*—Some further progress has been made with the preparation and final revision of the several tabular statements for the synoptical volume of the Great Arc Meridional Series, section 8° to 18° ; it may be considered about two-thirds done.

(*b*) *South-West Quadrilateral.*—The co-ordinate list of the Kathiawar Meridional Series was completed, finally revised and passed through the press.

(*c*) *The pamphlet of spirit-levelled heights, No. 1 Burma*, was examined, the appendix completed, and the whole passed through the press.

(*d*) *Tidal Volume.*—Very considerable progress has been made, 124 pages of part I and 92 pages of part II have been finally examined and passed through the press.

(*e*) *North-East Quadrilateral.*—Some progress has been made with the compilation of description of secondary stations.

CLASS 7.—EXAMINATION OF CHARTS.—The examination and comparison of two final charts for Synoptical Volume XXXIV (Káthiáwár Meridional Series) is about half done. The chart for the pamphlet of spirit-levelled heights, No. 1 Burma, was examined and passed through the press.

CLASS 8.—PROTECTION OF STATIONS.—The usual professional work in connection with the protection of survey stations and certain of the bench-marks in the North-Western

Provinces was performed. During the year, 616 stations were repaired by the district officers at a cost of R2,079-7-5. Thirty districts out of 346, from which reports are due, failed to submit them.

CLASS 9.—MISCELLANEOUS.—In this is included various duties which cannot be fairly assigned to any of the other classes, such as the following:—

The examination and despatch of printed papers to the Survey of India Office, Calcutta, for safe custody; the examination of all bound volumes and pamphlets prior to issue, and the preparation of the distribution lists, presentation labels and receipts for the same and the despatch of the volumes to the several recipients; the revision of old professional forms and preparation of new ones to meet the demands of field parties, etc., etc.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.—As hitherto a complete set of meteorological observations was taken daily throughout the year, and monthly and annual abstracts prepared. One officer of the Quarter Master General's Department was instructed in the use of the instruments necessary for exploration work; and the diaries of two native explorers were translated and their observations for latitudes and heights reduced. The meteorological results are given in the following tabular statements:—

MEAN MONTHLY READINGS OF EARTH THERMOMETERS.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1893-94	76·48	76·42	76·26	75·86	75·36	74·66	74·00	73·59	73·52	74·25	77·02	77·30
	Mean 1881—93	76·82	76·89	76·69	76·02	75·47	74·89	74·35	74·08	74·05	74·35	75·40	76·46
12·8	1893-94	79·19	78·06	76·08	73·92	72·00	70·46	70·61	72·67	75·15	77·93	79·83	79·47
	Mean 1881—93	79·43	77·98	75·64	73·02	71·38	70·66	71·33	73·12	75·18	77·10	79·02	29·65
6·4	1893-94	79·17	75·25	70·36	67·08	65·11	65·87	70·98	77·38	81·50	81·91	80·67	80·34
	Mean 1881—93	79·66	75·68	71·07	67·22	65·48	67·11	71·53	76·66	80·03	81·21	81·40	81·21
3·2	1893-94	77·29	70·17	64·78	61·68	61·51	65·07	75·87	83·72	85·76	83·00	80·49	80·53
	Mean 1881—93	78·12	71·66	65·60	61·91	61·19	66·62	75·35	81·60	84·52	83·30	82·15	81·59
1·1	1893-94	75·16	65·31	59·37	56·97	59·68	64·83	77·53	86·93	87·14	83·07	80·71	80·79
	Mean 1881—93	76·02	67·44	60·20	57·28	58·27	67·53	78·85	85·34	87·86	84·05	82·46	81·55
Thermometer in shade.	1893-94	78·33	70·49	66·07	62·51	65·13	75·89	89·64	97·19	87·20	80·20	78·23	81·15
	Mean 1881—93	80·64	73·73	68·34	64·23	66·83	78·60	90·06	93·17	90·71	82·37	80·75	82·36

Mean velocity in miles of the Winds which blew at Dehra Dun during the twelve months of 1893-94 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1	1·48	0·80	0·40	0·34	1·00	0·77	1·10	1·13	0.90	0·35	0·16	0·63	0·76
1 „ 2	1·06	0·37	0·23	0·59	0·85	0·74	0·83	1·10	0·69	0·39	0·23	0·57	0·64
2 „ 3	0·74	0·20	0·20	0·31	0·89	1·00	0·48	0·57	0·71	0·29	0·23	0·47	0·51
3 „ 4	0·58	0·20	0·13	0·17	1·04	0·87	0·41	0.50	0·57	0·35	0·17	0·40	0·45
4 „ 5	0·35	0·03	0·07	0·21	1·00	0·61	0·28	0·37	0·79	0·35	0·10	0·40	0·38
5 „ 6	0·35	0.07	0·10	0·14	0·74	0·65	0 69	0·40	0·75	0·55	0·07	0·31	0·40
6 „ 7	0·35	0·10	0·13	0·24	0·37	0·52	0·34	0·40	0·89	0·58	0·20	0·34	0·37
7 „ 8	0·19	0·03	0·03	0·45	0·22	0 32	0·41	0·60	1·21	0·74	0·23	0·14	0·38
8 „ 9	0·10	0·00	0·00	0·14	0·33	0·45	0·69	0·60	1·75	1·00	0·37	0·34	0·48
9 „ 10	0·58	0·17	0·17	0·17	0·67	0·87	1·24	1·47	2·18	0·87	0 63	0·76	0·82
10 „ 11	0·81	0·40	0·40	0·48	1·00	1·13	1·59	3·00	2·61	1·26	1·37	1·28	1·28
11 „ 12	0·94	0·60	0·50	0·72	1·41	2·00	2·28	3·27	2·39	1·23	1·43	1·17	1·50
12 „ 13	1·16	0·87	0·69	1·03	1·50	2·52	2·46	3·30	2·32	1·16	1·48	1·37	1·66
13 „ 14	1·32	0·90	0·63	1·63	1·69	2·48	2·82	4·23	3·03	1·58	1·45	1·50	1·94
14 „ 15	1·19	0·80	0·53	1·53	1·92	2·45	3·18	4·73	3·28	1·65	1·29	1·53	2 01
15 „ 16	1·19	0·57	0·33	1·00	1·85	2·45	2·86	4·83	2·69	1·65	1·13	1·17	1·81
16 „ 17	0·90	0·07	0·00	1·00	1·19	2·45	2·55	4·47	2·00	1·26	1·03	0·60	1·46
17 „ 18	0·19	0·17	0·03	0·41	0·52	1·06	1·03	3 80	1·72	0·94	0·86	0·20	0·90
18 „ 19	0·58	0·43	0·00	0·28	0·22	0·42	0·62	2·20	1·10	0·61	0·61	0·10	0·60
19 „ 20	1·26	0·93	0·10	0·17	0·33	0·77	1·10	1·70	0·52	0·39	0·23	0·20	0·64
20 „ 21	1·74	1·07	0·23	0·31	0·19	1·10	1·79	2·40	0·34	0·32	0 13	0·27	0·82
21 „ 22	1·77	1·33	0·27	0·28	0·59	0·94	1·38	2·10	0·34	0·32	0 19	0·33	0·82
22 „ 23	1·94	1·23	0·30	0·41	0·89	0·94	1·34	1·83	0·62	0·19	0·13	0·47	0·86
23 „ 24	1·77	0·93	0·37	0·45	0·67	0·84	1·10	1·77	0·76	0·19	0·26	0·97	0·84
Sums	22·54	12·27	5·84	12·46	21·08	28·35	32·57	50·77	34·16	18·22	13·80	15·52	...
Average	0·94	0·51	0·24	0·52	0·88	1·18	1·36	2·12	1·42	0·76	0·58	0·65	...

Monthly Meteorological Results of Observations taken at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer reduced to 32° Fah.						Hygrometer.		Thermometer.				Rain.		Wind.	Cloud.	
	At 10 A.M.			At 4 P.			10 A.M.	4 P.M.	Dry Bulb.			Wet Bulb.					
	Highest.	Lowest.	Monthly mea .	Highest.	Lowest.	Monthly mean.	Monthly mean humidity.	Monthly mean humidity.	Highest Maximum in Air.	Lowest Minimum in Air.	Monthly mean in Air.	Lowest Minimum.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 10 A.M.	At 4 P.M.
1893.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	°	°	°	°	°	°					
October	27·802	27·506	27·675	27·762	27·433	27·604	61	59	86·4	55·8	69·6	52·3	3	2·81	Calm.	1·7	2·4
November	·898	·721	·829	·805	·655	·750	60	53	77·7	44·9	60·0	42·3	2	0·93	„	1·5	2·4
December	·934	·714	·845	·849	·635	·752	63	57	71·5	41·9	55·9	39·3	0	0·01	„	2·2	4·9
1894.																	
January	·867	·669	·783	·794	·628	·701	73	62	72·6	39·3	53·8	37·5	6	2·77	„	4·8	5·3
February	·919	·628	·778	·816	·546	·695	68	61	76·6	41·8	57·5	40·2	5	4·46	„	5·7	7·1
March	·781	·488	·667	·667	·425	·586	47	36	89·4	45·1	64·9	42·2	3	2·64	„	2·6	3·4
April	·694	·428	·575	·588	·358	·486	32	23	97·4	58·9	77·4	51·5	0	*Nil.*	S.W. & W.	2·3	2·6
May	·621	·249	·457	·558	·159	·367	32	23	105·7	65·2	84·9	55·5	0	0·08	W.	1·1	2·5
June	·505	·278	·385	·390	·198	·297	69	64	103·8	69·5	81·9	58·2	15	17·83	S.E.	6·0	5·4
July	·589	·300	·422	·502	·232	·345	85	86	90·2	70·3	76·5	68·8	27	44·79	Calm.	8·7	8·4
August	·589	·253	·417	·541	·189	·344	87	88	86·5	69·8	75·3	69·0	31	32·76	„	8·9	9·0
September	·657	·429	·534	·535	·358	·439	78	75	88·1	66·3	75·6	64·7	12	8·03	„	5·0	5·8

CLASS II.—EXTRA-DEPARTMENTAL WORK.—This comprised the reduction of observations taken in Persia by Lieutenant Stothard and by Lieutenant the Hon'ble H. Napier for time, azimuth, latitude and height; they were in the hands of a pair of computers for a little over a month.

TYPE PRINTING SECTION.—With the exception of 302 pages printed for other departments, the working power of this section has been solely directed to the publication of the records of this branch of the Survey of India Department, and to the printing of most of the forms, professional and otherwise, for this office, for the tidal and levelling party and other field parties. Hitherto about three-fourths of the forms were printed by the Photo-zinco Section, but these have all been transferred to this section.

The following statements give the out-turn of work, which bears a very satisfactory comparison with those for the preceding years :—

Statement of work done during 1893-94.

SPECIFICATION OF PRINT.	No. of pages.	Total number of pulls.	No. of copies of each page.	Value.
				₹
Professional Volumes	214	30,950	510	5,525
Synoptical Volumes	184	19,470	360	4,351
Pamphlets of spirit-levelled heights . . .	86	4,320	310	1,353
Letter-press for charts, map headings, and foot-notes	174	3,300	...	1,038
Forms	346	89,990	...	5,912
Extra-departmental work	302	39,640	...	977
TOTAL .	1,306*.	187,670		19,156

* Equal to 1,638 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1889-90.	1890-91.	1891-92.	1892-93.	1893-94.
Pages composed	1,998	2,165	2,228	2,195	1,638

The out-turn during the year is small, but this is entirely due to the reduction of establishment.

An analysis of the pages composed in 1893-94 is as follows :—

		Pages.
PROFESSIONAL VOLUMES . .	Tidal Volume	408
	Burma Coast Series	15
	Total .	423
SYNOPTICAL VOLUMES . .	Káthiáwár Meridional Series . . .	132
	Great Arc Meridional Series . . .	138
	Total .	270
MISCELLANEOUS	Spirit-levelled heights, No. 1 Burma . .	68
	Letter-press for charts, map-headings and foot-notes	95
	Forms, orders, memoranda, etc. . . .	481
	Extra-departmental work	283
	Total .	945

PHOTO-ZINCOGRAPHIC SECTION.—This section has been partly employed in printing maps, charts, diagrams, etc., to illustrate the professional and synoptical volumes and other pamphlets published by this branch, and in addition it has again executed a large amount of extra-departmental work, chiefly for the Quarter Master General's and the Forest Departments.

About the beginning of the rains it was found that the method of intensifying the negatives by means of bichloride of mercury and hydrosulphuret of ammonia was not very satisfactory, and Major Gore determined to introduce the method of intensifying by bromide of copper as used in the Head Quarters Office in Calcutta. The change gave excellent work in all except one point. The negatives here must, as a general rule, be kept, and therefore require some stronger varnish than the gelatine one used in Calcutta. The varnish formerly used was a shellac spirit varnish which answered with the old way of intensifying; but when it was applied to the negatives intensified with copper, it tore the film and produced a mass of pin holes. To obviate this, gelatine in a thin solution was first applied and then the varnish. The film did not now suffer, but it was so brittle that the negative could not be cut at all. Several attempts were made to get over the difficulty, and it was at last surmounted by the adoption of a crystal benzol varnish composed as follows:—

Gum damar	English, obtained from Messrs. Smith, Stanistreet & Co.	1 oz.	A
Benzol 90%	Obtained from Messrs. Waldie & Co.	6 oz.	
Gum copal	Obtained in Dehra	1 oz.	B
Benzol 90%		8 oz.	

Two parts of A mixed with one of B

In making up this varnish it will be found that very little of the copal gum will dissolve in the benzol, but the amount is sufficient to allow the film to be cut without splitting as it appears to do when varnished with damar and benzol only. There is a very great difference in the gums obtained in different places under the same names, one so-called damar gum obtained in Dehra producing a very fine ground glass varnish.

The following tables exhibit the value and out-turn of work done by this section:—

Statement showing the amount of work done for other Departments, etc., during the year 1893-94.

Departments, etc.	Photo-zincographic Printing.							
	Sheets or sections or subjects.	Negatives.	Photo-transfer Prints.	Zinc Plates.	Silver Prints.	Blue Prints.	Pulls.	Copies.
Forest Department	220	482	192	93	...	1,877	8,086	9,888
Quarter Master General	3	4	12	4	...	...	424	212
Special work done for private individuals	12	6	12	3	...	...	1,240	1,240
Totals	235	492	216	100	...	1,877	9,750	11,340

Table showing the amount realized from other Departments, etc., by Book-debit and Cash sales during 1893-94.

Departments, etc.	By Book-debit.		By Cash sales.		Total.	
	₹	a.	₹	a.	₹	a.
Forest Department	828	7	152	13	981	4
Forest Survey	4,802	13	488	6	5,291	3
Quarter Master General	966	4	148	13	1,115	1
Military Department	70	9	24	8	95	1
Other Departments	.....		319	4	319	4
Private individuals	.....		260	10	260	10
Totals	6,668	1	1,394	6	8,062	7

Specification of Plate or Print.	Progress made.	Photo-zincographic Printing.										Remarks.
		Scale of map.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.
		1 inch										₹ a.
Aden, Tidal Diagram	F.	...	1/8 D. E.	1	1	2	1	...	...	255	510	41 4	For Professional Volume (Tidal).
Astor and Gilgit, with surrounding country (corrected to 1883)	* F.	4	D. E.	1	2	11	1	...	...	103	103	85 0	
Beypore, Tidal Diagram	F.	...	1/8 D. E.	1	1	2	1	...	...	255	510	41 4	For Professional Volume (Tidal).
Central Provinces Survey, Sheets Nos. 23 S.E./1 & 3, S.E./4; 24 N.E./2, N.E./4, S.W./3; 25 S.E./1; 26 N.W./1; 34 S.E./2 & 4 and 50 N.E./1 & 3 (in one); 34 N.E./3 and N.W./4 (in one); N.W./3 and S.W./1 (in one); N.E./3, S.E./1, S.E./3, S.E./4, S.W./2, S.W./3, S.W./4; 35 N.E./1 & 2, N.E./3 & 4, N.W./1, N.W./2, N.W./3, N.W./4, S.W./1 and S.W./2	F.	1/4	D. E.	25	111	139	25	...	140	3,750	3,775	2,347 2	
Chamba Territory	* F.	1/2	1/2 D. E.	1	4	4	4	...	...	410	410	134 2	
Clinometer Height Indicator and contouring scale (Captain Wahab's)	I.	...	1/16 D. E.	1	1	2	1	...	...	...	..	14 6	
Cutch Coast Series, Final Chart, Sheets Nos. 1 and 2	F.	8	1/8 & 1/4 D. E.	2	7	14	3	...	...	550	740	189 8	For Synoptical Volume No. XXXIII.
Dehra Dun and Siwaliks Survey, Sheet No. XXII	* F.	1/4	D. E.	1	2	2	1	...	...	30	30	43 10	
Diagram of Tide-predicting machine	F.	...	1/8 D. E.	3	3	...	...	6	...	...	6	30 10	For Professional Volume (Tidal).
Eastern Trans-frontier, Sheet No. 7 N.W.	* F.	4	D. E.	1	...	...	...	...	...	50	50	10 12	
Forms for departmental use (Miscellaneous)	F.	...	...	5	...	4	1	...	...	990	1,310	163 4	
Gujarat Survey, Sheets Nos. 9, 27, 28 and 35	* F.	4	D. E.	4	...	36	4	...	...	600	600	315 0	
Hazara Expedition, 1891, sheets Nos. 1 and 2	* F.	1/2	D E.	2	...	12	2	...	...	206	206	97 4	
Hoshangabad Survey, Triangulation Chart	F.	...	1/4 D. E.	1	2	...	...	6	...	...	3	24 14	
Isazai Expedition, 1892, with outer border lines, etc.	* F.	1/2	D. E.	1	...	...	...	...	...	105	106	21 12	
Kálka Town Survey, Sheets Nos. 1, 2, 3, 4 and 5	I.	...	D. E.	5	24	24	5	...	...	...	...	292 12	
Karáchi Tidal Diagram	F.	...	1/8 D. E.	1	...	2	1	...	...	255	510	35 0	For Professional Volume (Tidal).
Kátwár Tidal Diagram	F.	...	1/8 D. E.	1	1	2	1	...	...	255	510	41 5	
Mandalay Meridional Series, Preliminary Chart of Principal Triangulation, Sheet No. 4, Season 1892-93	F.	4	D. E.	1	6	6	1	...	...	62	62	84 0	
Map to illustrate tribal settlement on the North-Western Frontier	F.	24	1/4 D. E.	1	9	9	1	...	...	60	30	114 12	
Monghsat Series, Preliminary Chart of Secondary Triangulation, Sheets Nos. 1 and 2, Season 1891-93	F.	4	D. E.	2	16	16	2	...	...	130	130	209 6	
Mussooree and Landour, Guide Map	* F.	1/2	D. E.	1	...	...	...	...	...	50	50	10 12	
Mussooree and Landour Survey, Sheet No. 16 (Shaded)	* F.	1/12	D. E.	1	7	7	1	...	...	30	30	83 12	
North-Eastern Frontier, Sheets Nos. 5 and 6	F.	16	1/2 D. E.	2	4	...	...	...	8	...	4	27 10	
Port Blair, Tidal Diagram	F.	...	1/8 D. E.	1	1	4	2	...	...	255	510	60 8	For Professional Volume (Tidal).
Punjab Survey, Sheets Nos. 264 S.E./4; 265 N.E./1, N.E./4, S.E./3; 285 N.W./4, S.W./1, S.W./3, S.W./4; 286 N.W./2; 290 N.E., N.W. S.E.; 291 N.E.; 309 S.E./4; 311 N.W. S.W./3 & 4; 312 N.W., S.W.; 313 N.W./1, N.W./2, N.W./3, N.W./4, S.E., S.W./1, S.W./2, S.W./4; and 314 N.E.	F. & I.	1/4 & 1/2	D.E., 1/16 & 1/4 D.E.	27	101	89	19	...	90	1,124	1,172	1,425 6	
Punjab Survey, Plane Table, Nos. 312 S.E./L. (in two sheets), S.E./R. (in two sheets); 313 N.E./L. (in two sheets), and N.E./R. (in two sheets)	F.	1	1/8 D. E.	8	4	...	...	...	8	...	16	27 9	
Quetta Civil Station Sheets, Nos. 1 and 2 (2nd Edition)	F.	16	D. E.	2	12	12	2	...	...	300	300	198 14	
Ránikhet Cantonment	* F.	1/2	1/8 D. E.	1	1	1	1	...	...	27	27	15 8	
Spirit-levelling Operations, No. 1 Burma, 1892-93	F.	16	1/2 D. E.	1	2	4	1	...	...	155	310	73 12	For Pamphlet of Spirit-levelled heights.
Other maps for office use, Surveyor-General's Office, etc.	F. & I.	...	...	47	108	171	57	...	40	53	2,790	112 12	

Copies of Maps of other Departments taken for Departmental use.

Berar, Ghordara Forest Reserve	...	$\frac{1}{8}$	D. E.	1	...	...	...	...	...	20	20	7 0	Copies retained for office record of maps, etc., requisitioned for by other departments, the cost of press pulls and stationery being all that is here charged to the Survey Department; the numbers in columns 5 to 8 therefore stand excluded from the totals.
Do. Nidha Forest Reserve	...	$\frac{1}{4}$	D. E.	1	...	...	...	...	...	15	15	5 8	
Bombay, Borgaon Forest Reserve	...	$\frac{1}{8}$	$\frac{1}{8}$ D. E.	1	...	...	...	...	...	20	20	4 4	
Burma (Lower), Index to the Forest Survey in the Tenasserim Circle, East and West Salween	...	32	$\frac{1}{4}$ D. E.	1	...	...	...	...	...	5	10	2 2	
Burma (Upper), Index to the Forest Survey, District Pyinmana	...	8	$\frac{1}{8}$ D. E.	1	...	...	...	...	...	8	16	1 14	
Central Provinces, Ahiri Zamindari Forest Survey, Sheets Nos. 122 $\frac{\text{N.W.}}{4}$ and $\frac{\text{S.W.}}{2}$ (in one), $\frac{\text{S.W.}}{3 \& 4}$; 123 $\frac{\text{N.W.}}{1 \& 2}$, $\frac{\text{N.W.}}{3 \& 4}$, $\frac{\text{S.W.}}{1 \& 2}$ and $\frac{\text{S.W.}}{3 \& 4}$	...	$\frac{1}{4}$	D. E. & $\frac{1}{2}$ D. E.	6	...	...	...	...	...	90	90	38 4	
Central Provinces, Bhandara Forest Survey, Sheets Nos. 92 $\frac{\text{N.E.}}{2}$, $\frac{\text{N.W.}}{3}$, $\frac{\text{N.W.}}{4}$, $\frac{\text{S.E.}}{1}$ and $\frac{\text{S.E.}}{2}$	...	$\frac{1}{4}$	D. E. & $\frac{1}{2}$ D. E.	5	...	...	...	...	...	75	75	21 8	
Central Provinces, Bhiwkund Forest Reserve	...	$\frac{1}{4}$	D. E.	1	...	...	...	...	...	15	15	6 6	
Ditto, Dabdi Forest Reserve	...	$\frac{1}{4}$	D. E.	1	...	...	...	...	...	15	15	6 6	
Ditto, Index to the Forest Survey in the Balaghat Division	...	8	$\frac{1}{8}$ D. E.	1	...	...	...	...	...	15	15	1 14	
Ditto, Index to the Forest Survey in the Chindwara, Seoni, Nagpur and Wardha Divisions	...	16	$\frac{1}{4}$ D. E.	1	...	...	...	...	...	3	12	2 2	
Ditto, Index to the Forest Survey in the Narsinghpur Division	...	8	$\frac{1}{8}$ D. E.	1	...	...	...	...	...	8	16	1 7	
Ditto, Jubbulpore Forest Survey, Sheets Nos. 85 $\frac{\text{N.E.}}{2}$; 86 $\frac{\text{S.E.}}{2}$, $\frac{\text{S.E.}}{4}$, $\frac{\text{S.W.}}{2}$; 105 $\frac{\text{N.E.}}{4}$; 106 $\frac{\text{N.E.}}{4}$, $\frac{\text{N.W.}}{1}$, $\frac{\text{N.W.}}{4}$, $\frac{\text{S.E.}}{1 \& 3}$, $\frac{\text{S.E.}}{4}$, and 107 $\frac{\text{N.E.}}{2}$ (one); 106 $\frac{\text{S.E.}}{3}$, $\frac{\text{S.W.}}{4}$, and 107 $\frac{\text{N.W.}}{2}$ (in one); 107 $\frac{\text{S.E.}}{1}$, $\frac{\text{S.E.}}{2}$, $\frac{\text{S.W.}}{2}$, $\frac{\text{S.W.}}{3}$, $\frac{\text{S.W.}}{4}$; 108 $\frac{\text{N.E.}}{3}$, $\frac{\text{N.W.}}{1}$, $\frac{\text{N.W.}}{2}$, $\frac{\text{N.W.}}{3}$, $\frac{\text{N.W.}}{4}$; 128 $\frac{\text{N.E.}}{4}$, $\frac{\text{S.W.}}{3}$, $\frac{\text{S.W.}}{4}$, and 129 $\frac{\text{N.W.}}{2}$ (in one); 129 $\frac{\text{N.W.}}{1 \& 2}$, $\frac{\text{N.W.}}{3}$; 130 $\frac{\text{N.E.}}{3}$, $\frac{\text{N.W.}}{4}$ and $\frac{\text{S.W.}}{3}$	...	$\frac{1}{4}$	D. E. $\frac{1}{8}$, $\frac{1}{4}$, $\frac{2}{3}$ & $\frac{3}{4}$ D. E.	29	...	...	...	...	...	385	385	146 14	
Ditto, Phiski Forest Reserve	...	$\frac{1}{8}$	$\frac{3}{4}$ D. E.	1	...	...	...	...	...	20	20	7 0	
Ditto, Pownar Forest Reserve	...	$\frac{1}{8}$	D. E.	1	...	...	...	...	...	15	15	7 5	
Ditto, Raipur Forest Survey, Sheets Nos. 141 $\frac{\text{N.E.}}{4}$ and 164 $\frac{\text{N.W.}}{3}$ (in one); 141 $\frac{\text{S.E.}}{2}$ and 164 $\frac{\text{S.W.}}{1}$ (in one); 187 $\frac{\text{N.E.}}{1}$, $\frac{\text{N.E.}}{3}$, $\frac{\text{N.E.}}{4}$, $\frac{\text{N.W.}}{3}$, $\frac{\text{N.W.}}{4}$, $\frac{\text{S.E.}}{1}$, $\frac{\text{S.E.}}{3}$, $\frac{\text{S.W.}}{1}$, $\frac{\text{S.W.}}{3}$, $\frac{\text{S.W.}}{4}$; 208 $\frac{\text{N.W.}}{1}$ and $\frac{\text{N.W.}}{3}$	...	$\frac{1}{4}$	D. E. & $\frac{1}{2}$ D. E.	14	...	...	...	...	...	155	155	77 10	
Ditto, Umbarde Forest Reserve	...	$\frac{1}{8}$	$\frac{3}{4}$ D. E.	1	...	...	...	...	...	20	20	7 0	
Dehra Dún, Suswa Coppice Working Circle	...	$\frac{1}{8}$	$\frac{1}{2}$ D. E.	1	...	...	...	...	...	15	15	4 0	
North-Western Provinces and Oudh, Bhongaon Forest Reserve	...	$\frac{1}{8}$	$\frac{1}{2}$ D. E.	1	...	...	...	...	...	20	20	5 12	
Ditto ditto, Index to the Forest Survey of Districts Kheri and Pilibhit	...	8	$\frac{1}{8}$ D. E.	1	...	...	...	...	...	8	16	1 7	
Punjab Forest Survey, Bashahr State, Sheets Nos. 347 $\frac{\text{N.E.}}{4}$, $\frac{\text{N.W.}}{1}$ and $\frac{\text{N.W.}}{4}$	...	$\frac{1}{4}$	$\frac{1}{8}$ & $\frac{1}{2}$ D. E.	3	...	...	...	...	...	45	45	12 0	
Other maps	...	4	D. E.	2	...	...	...	...	...	56	28	12 8	
TOTALS	...	...	...	227	430	575	138	12	262	16,376	15,848	9,753 9	

* Additional prints of previous publications; D. E. represents double elephant; F. represents finished; I. re presents in press.

SOLAR PHOTOGRAPHIC SECTION.—The details of the work of this section are given below:—

Table showing the number and character of the negatives.

1893-94.	Number of Days.				Number of Negatives.										Number of working days when solar Phenomena were	
		Failures.			Solar Phenomena.								Total.			
	When negatives were taken.	From bad weather.	From various causes.	Total.	Spots and faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	29	2	...	31	48	...	...	...	...	...	...	...	48	...	29	...
November	28	2	...	30	52	...	...	...	...	...		...	52	...	28	...
December	28	3	...	31	50	...	...	...	...	...	...	...	50	...	28	...
January	23	8	...	31	43	...	...	...	...	...	...	...	43	...	23	...
February	20	8	...	28	31	...	...	...	...	...	...	...	31	...	20	...
March	28	3	...	31	53	...	...	...	...	...	...	...	53	...	28	...
April	29	1	...	30	52	...	...	..	...	...	...	...	52	...	29	...
May	31	...	...	31	58	...	...	...	...	...	...	...	58	...	31	...
June	24	6	...	30	42	...	...	...	...	...	...	...	42	...	24	...
July	22	9	...	31	33	...	...	...	...	...	...	...	33	...	22	...
August	17	14	...	31	25	...	...	...	1	...	...	...	26	...	17	...
September	25	5	...	30	44	...	...	...	...	...	...	...	44	...	25	...
TOTAL	304	61	...	365	531	...	...	...	1	...	...	...	532	...	304	...

Nine hundred and fifty-five silver prints of the 8-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table showing the visibility of Sun at Dehra Dun and Greenwich.

Year.	At Dehra Dun.			At Greenwich.		Remarks.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days on which sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88	205	
1889-90	320	78	45	1888-89	182	
1890-91	303	99	62	1889-90	212	
1891-92	304	100	62	1890-91	224	
1892-93	292	100	73	1891-92†	219	† Year ending 10th May 1892, obtained from the report to the Board of visitors.
1893-94	304	100	61	1892-93	Not obtainable.	
Mean	306	...	59	...	197	

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement showing the work performed during 1893-94.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
Standard Maps.		In. M.	
Hazara Expedition, 1891-92, sheets Nos. 1, 2 and 3	3	1=½	Corrections in hand.
Mussoorie and Landour	1	1=12	Original corrected and final press order given.
Kumaon and Garhwal, sheets Nos. 19 and 24	2	1=1	Touched up for photography; final press order given.
Central Provinces Survey sheets, Nos. 34 S.W./1 and S.W./3; 34 S.W./2; 34 N.W./4; 34 S.E.; 35 N.W./1; 35 N.W./2; 35 N.E./3 & 4; 26 N.W./1; 14 S.W./1 (Nimar)	9	1=¼	Touched up for photography; final press order given.
Punjab Survey, Sheets Nos. 290 N.E.; 290 S.E.; 312 N.W.; 311 N.W.; 312 S.W.	5	1=½	Touched up for photography; final press order given.
Sheets Nos. 308 N.W./2; 308 N.W./4; 264 S.E./2; 264 N.E./4 265 N.E./1	5	1=¼	
North-Eastern Trans-frontier sheet No. 7	1	1=4	Corrections completed. In hand.
Gujarat Survey, sheet No. 10	4	1=1	Corrections completed. Final press order given.
Plans of Cities and Cantonments, etc.			
Dehra Municipality and Cantonment (2nd Edition)	3	1=12	In hand.
Index Maps.			
Triangulation Chart of India	1	1=96	Brought up to date for Annual Report.
To illustrate progress of Nos. 14 and 18 Parties	2	Various	Ditto ditto.
Charts.			
Triangulation Chart, Káthiáwár Meridional and Coast Series	2	1=4	Corrected and completed for reproduction to ½ scale. In hand.
Triangulation Chart Great Arc Series Section, 8° to 18°	4	1=4	In progress.
Miscellaneous.			
Tidal maps of Beypore, Aden and Port Blair	3	Various	Final press order given.
Tidal maps of Cochin and Pamban	2	,,	In press.
Tidal maps of Port Albert Victor, Tuticorin, Point-de-Galle, Negapatam, Madras, False Point, Akyab, Amherst, Moulmein Trincomalli, Bhavnagar, Minicoy, Bombay and Rangoon	14	,,	In hand.
Map of Black Mountain and adjoining country	1	1=2	In hand.
Rough plots of two explorers' routes	2	1=16	Fair plots in hand.
General map to illustrate the record of expeditions against the North-Western Frontier Tribes, 1884	1	1=24	Prepared sheet with names for zinco-printing. Final press order given.
Other maps	34	Various	Completed headings, foot-notes and references for press.
Maps coloured	1845	,,	.....

Statement showing the work performed during 1893-94—contd.

MAPS EXAMINED.

	No. of Sheets.
Original Standard Maps	77
Charts	4
Miscellaneous Maps	40
Photographic proofs of Standard Sheets and other Maps	207
TOTAL	328

N.B.—In addition to the above, other miscellaneous duties have been performed, such as assisting in the Photographic Section; completing Central Provinces Survey and Punjab Survey original maps in respect to headings and foot-notes, etc., for press; supplying tracings of margins of sheets to Simla Drawing Office and No. 18 Party; examination and custody of ecords; adjusting various instruments for the Imperial Forest School; making all the despatches of maps, etc., etc.

Statement of work done for other Departments during 1893-94.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
		In. M.	
Standard Maps.			
Forest Surveys	58	1 = ¼	Completed headings, foot-notes and references. Final press order given for Forest Department.
Index Maps.			
Forest Surveys	6	Various	Ditto ditto ditto.
Miscellaneous.			
Forest Department	11	„	Ditto ditto ditto.
Quarter Master General's Department	1	1 = 4	Compiled and final press order given.
Palwal Town Traverse	8	1=50 ft.	Plotted for the Deputy Commissioner, Gurgaon.
Ditto ditto	12	1=100 ft.	
Traverses plotted in Káthiáwár sheets Nos. 27, 28, 38 and 39.	7	1 = ½	For Junagadh State.

Statement showing the value of work done for other Departments, etc., during 1893-94.

DEPARTMENTS, etc.	Value.		
	R	*a.*	*p.*
Forest Department	132	0	0
Foreign Department (Secretary)	53	11	0
Military Department („)	18	1	0
Junagadh State	90	0	0
TOTAL	293	12	0

G. I. C. P. O.—No. 20 S. C.—13-4-95.—450.

1895.

File No. 81.

GOVERNMENT OF INDIA.

SERIAL NO. 2.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND SURVEYS.

RESOLUTION.

No. $\frac{13}{81-2}$.

Dated Simla, the 7th June 1895.

SUBJECT.

General Report on the operations of the Survey of India Department during the year 1893-94.

G. C. Press, Simla.—No. 160 R. & A. D.—7-6-95.—685.

No. $\frac{13}{81-2}$.

File No. 81.

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture (Land-Surveys), dated Simla, the 7th June 1895.

SERIAL NO. 2.

READ—

The General Report on the operations of the Survey of India Department during the year 1893-94.

RESOLUTION.

Excluding the work of the Forest Survey Branch, which is noticed in paragraph 5 of this Resolution, the field operations during the year under review were carried on by twenty parties (of which two were double parties) and four small detachments. The various classes of work on which they were engaged are shown below :—

Class of work.	Number of parties employed.	Number of detachments employed.
1. Trigonometrical	1	...
2. Topographical	3	2
3. Forest (excluding the Imperial Forest Survey Branch)	4	...
4. Cadastral	6 (two double)	2
5. Traverse	1	...
6. Scientific	3	...
7. Geographical	2	...
Total ...	20	4

Thus eleven parties and two detachments were engaged on remunerative operations connected with land or forest revenue, as compared with twelve parties and one detachment in 1892-93.

2. The aggregate area surveyed on all scales during the year under report was 127,477 square miles, against a total of 104,711 square miles in 1892-93. These figures do not include the traverse operations carried on in the Central Provinces as a basis for field surveys under the Settlement Department, or the skeleton survey of village boundaries in Bengal. These two operations covered a further total area of 3,572 square miles in 1893-1894, and of 3,563 square miles in the preceding year.

3. The party which has been employed during the past three years on trigonometrical surveys extended, during the year under report, the principal triangulation northwards in Upper Burma over a direct distance of 90 miles, besides carrying a secondary series of triangles over 70 miles along the coast south-eastwards from Karachi.

As in the preceding year, three parties were employed on topographical surveys in the Bombay Presidency, in Baluchistan and in the Himalayas; one detachment continued the survey of the river Indus in Sind; while another was

formed for the survey of the peninsula of Aden and of that portion of the Yafi'i country in Arabia which was left unfinished in the year 1891-92. A total area of 16,072 square miles was topographically surveyed, as compared with 10,215 square miles in the previous year, in addition to small areas surveyed by cadastral parties in the Shwebo and Amherst districts of Burma and by the Forest Survey Branch in the Bashahr State. The two parties employed on geographical survey in Upper Burma having practically completed their preliminary operations, a detachment from one of these parties has begun the topographical survey of that province.

4. The total area of forest surveyed in the Central Provinces, Bombay, Madras, and Lower Burma by the four parties of the Imperial Survey Department employed exclusively on that work, and in the Himalayas by a topographical party, amounted to 2,522 square miles.

5. The report under review includes for the first time an account of the operations of the Forest Survey Branch, which is under the administration of the Inspector General of Forests and under the superintendence of a Deputy Superintendent of the Survey of India Department. The officers of the Branch are now included in the cadre of that Department. During the year the Branch surveyed 1,433 square miles of forest proper, situated in the Punjab, the Central Provinces, Oudh, and Burma, as well as of 287 square miles of non-forest land in Bashahr (Punjab), which was surveyed on the 1-inch scale for incorporation with topographical surveys.

It is understood from the Inspector General of Forests that these forest maps, although they result from surveys conducted by cheaper agency than the Surveyor General feels able to rely upon, meet all forest requirements both in accuracy of detail and neatness of execution. Under these circumstances the Government of India do not consider it necessary to provide for more costly supervision. They are glad to observe that in other respects the system as carried out by the Superintendent, Mr. W. H. Reynolds, is held by the Surveyor General to be quite satisfactory.

6. Cadastral surveys were carried on by two double parties and a detachment in Bengal, by three parties in Burma, by one in Assam, and by a detachment in the North-Western Provinces. The total area completed during the year was 8,280 square miles, being an increase of 525 square miles as compared with 1892-93. The cost of the different operations of Traverse, Cadastral survey, and record-writing varies considerably from area to area. Explanations of excess cost are in most instances forthcoming; but there is nothing to show why record-writing should cost Rs. 74 per square mile in Palamau, Rs. 78 in Muzuffarpur, and Rs. 70 in Balasore, when it can be done for Rs. 50 in Sarun and for Rs. 54 in Champaran. Full explanation is always desirable in each case where the cost of cadastral work in India exceeds Rs. 70 per square mile. It is recognized that work cannot be carried out in Burma at anything approaching that rate as yet, though it has been found possible to reduce the cost in Magwe to Rs. 111.

7. One party was again employed in traverse surveys in the Central Provinces. and the total area traversed amounted to 3,397 square miles, which compares favourably with the outturn for last year. In Bengal the Traverse survey of village boundaries in the Gya and Shahabad districts was completed over an area of 175 square miles.

8. The latitude observations of last year were continued by two astronomical parties; and the latitude and longitude observations are practically complete, and only await that connection with Greenwich which is now in progress. Tidal

observations have been continued at 13 stations, and predictions will now be published for 35 tidal stations. In connection with these operations, 370 miles of double levelling have been run; and the results in both cases reached a very high standard of accuracy.

The two parties employed on the geographical survey of Upper Burma covered an area of 14,790 square miles, thus bringing the task to completion. Reconnaissance surveys were made of over 84,000 square miles in Persia and Arabia and on the north-western frontier, of which the greater portion had not been previously mapped.

9. The work done in the various Head-Quarters offices seems to have been satisfactory. The value of the extra-departmental work done in the Photographic and Lithographic offices decreased from Rs. 91,118 to Rs. 71,141, owing to a smaller demand. On the other hand, the value of original maps and drawings reproduced for the Department itself increased from Rs. 81,128 to Rs. 98,760. The quality of the work executed under Colonel Waterhouse's supervision maintained its high standard of excellence. The two specimens of photo-etching bound up with the report are admirable specimens of what the department can do in the way of artistic finish: while the map work for accuracy and clearness leaves nothing to be desired.

The Drawing Office continued to be principally employed on maps of Burma. A Provincial Drawing Office for Bengal was organised during the year for the preparation of topographical maps from the results of cadastral surveys, as the field parties in Bengal could not cope with the heavy mapping work The demands on the Mathematical Instrument office for scientific instruments were considerably less than in 1891-92 and 1892-93; but there was a larger outturn of work in the shape of repairs.

10. Pages 16 and 17 of the report contain a summary of the operations of the Department for the nine years during which it has been under the administration of Colonel Sir Henry Thuillier, R.E., who has recently retired from the office of Surveyor General of India. During that period the area covered by Cadastral, Forest, Topographical and Geographical surveys aggregated 844,218 square miles. The surveys of 17 cities and towns, including Calcutta, have also been mapped on various large scales; while 93,694 square miles of Traverse surveys and 25,140 square miles of principal and secondary triangulation have been completed during the same period. Upper Burma has been added to the Geographical map of India; the latitude and longitude observations have been completed; the system of tidal observations and predictions has been largely extended; and a double line of spirit levelling has been carried over a distance of more than 4,000 miles. The Governor General in Council has already taken occasion to express his sense of the value of Colonel Thuillier's services.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor General of India, the Inspector General of Forests, Local Governments and Administrations noted on the margin, and to the Foreign, Military and Public Works Departments.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

Ordered also that the Resolution be published in the Supplement to the *Gazette of India*.

(True Extract.

DENZIL IBBETSON,

Offg. Secretary to the Government of India.

Photo-etching. Survey of India Offices, Calcutta, January 1896.

A. H. Hamilton

Reduced from a photograph by Messrs Bourne & Shepherd.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1894-95.

PREPARED UNDER THE DIRECTION OF

COLONEL C. STRAHAN, R.E.,

SURVEYOR-GENERAL OF INDIA.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

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CONTENTS.

PART I.

SUMMARY.

	PAGE
Administration	1
Field Parties	2
Outturn	4
Trigonometrical Surveys	4
Topographical Surveys	4
Forest Surveys	5
Cadastral Surveys	6
Traverse Surveys	8
Special Operations	9
Geographical Surveys	9
Head-Quarters Offices	10
Establishment	13

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

No. of Party.		PAGE Report.	Appendix.
	Trigonometrical Surveys.		
24.	Burma and the Indus Delta Coast	15	i
	Topographical Surveys.		
10.	Southern Maratha Country	16	...
11.	Upper Burma	17	...
15.	Baluchistan	19	...
18.	Himalayas, Punjab	21	...
21.	Upper Burma	24	...
Det.	Indus River, Sind	26	...
„	Orissa	27	...
„	Waziristan	30	...
	Forest Surveys.		
14.	Central Provinces	31	...
17.	Bombay Presidency	34	...
19.	Madras ditto	37	...
20.	Lower Burma	38	...
	Operations of the Forest Survey Branch	40	...
	Cadastral Surveys.		
2 & 8.	Bengal and Bihar	44	...
3.	Yamethin, Shwebo, Katha, etc., Districts, Upper Burma	54	...
4 & 5.	Bihar	61	...
6.	Assam	68	...
7.	Amherst and Thaton Districts, Lower Burma	70	...
12.	Magwe and Myingyan Districts, Upper Burma	73	...

No. of Party.		PAGE Report.	Appendix.
	Traverse Surveys.		
9.	Central Provinces	75	...
Det.	North-Western Provinces and Oudh	77	...
	Geodetic.		
22 & 23.	Longitude Operations	80	...
25.	Tidal ditto	82	iv
	Levelling ditto	85	xxxiii
	Geographical Surveys.		
Det.	Operations with the Mekong Mission	86	...
„	Ditto Pamir Commission	89	...
„	Ditto Chitral Relief Force	90	...
	Tabular Statements.		
	Outturn of work of the Field Parties	92	...
	Cost-rates of ditto ditto	96	...
	Particulars of Cadastral Surveys completed in 1894-95	98	...

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

	PAGE Report.	Appendix.
Head-Quarters Offices, Calcutta	99	...
Superintendence, Correspondence, and Accounts	99	...
Drawing Office	100	xxxvii
Bengal Provincial Drawing Office	102	...
Engraving Office	104	xlix
Photographic and Lithographic Office	105	l
Map Record and Issue Office	108	...
Mathematical Instrument Office	109	lx
Trigonometrical Branch Office, Dehra Dun	112	lxviii
Drawing Office, Simla	114	...
Forest Survey Branch Office, Dehra Dun	114	...
List of maps published during the year	116	...

APPENDIX.

EXTRACTS FROM REPORTS BY EXECUTIVE OFFICERS.

No. of Party.		PAGE
24.	Burma and the Indus Delta Coast Triangulation	i
25.	Tidal and Levelling Operations	iv
	Drawing Office, Calcutta	xxxvii
	Engraving Office, Calcutta	xlix
	Photographic and Lithographic Office, Calcutta	l
	Mathematical Instrument Office, Calcutta	lx
	Trigonometrical Branch Office, Dehra Dun	lxviii

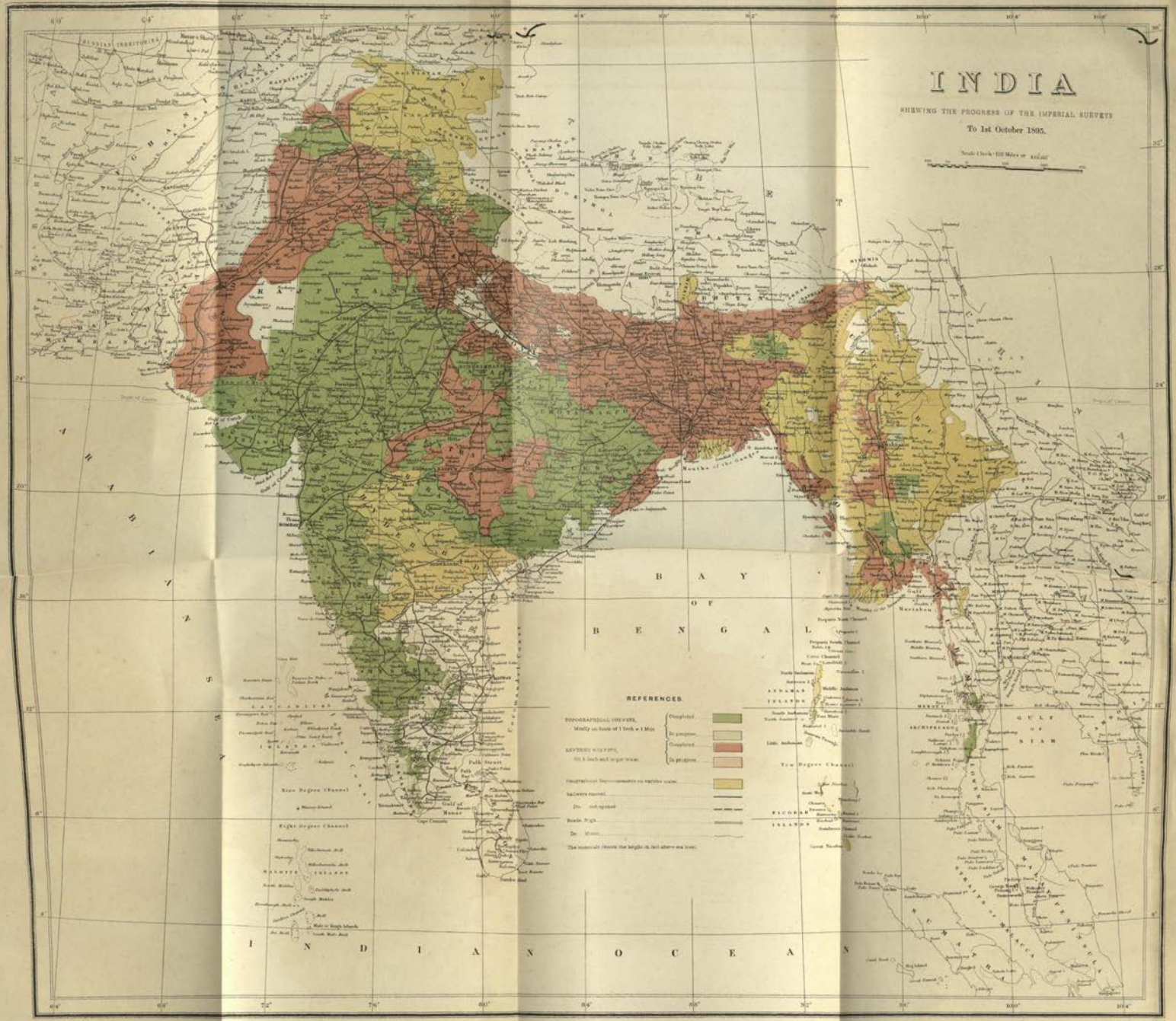
ILLUSTRATIONS.

PHOTO-ETCHINGS, etc.

	TO FACE PAGE Report. Appendix.
Portrait of Sir H. R. Thuillier, K.C.I.E., R.E.	Frontispiece.
The Malakand Pass and the Chitral bridge and fort	90 ...
India (with hills inserted by heliogravure)	107 ...
Kila Drosh (enameline process)	... lii

MAPS.

	TO FACE PAGE
India, showing progress of Imperial Surveys to 1st October 1895	1
Index Chart to the Great Trigonometrical Survey of India	*ib.*
Index to the Trigonometrical Survey in Upper Burma	15
" " Topographical Survey in Southern Maratha country	16
" " " " in Upper Burma	18
" " " " in the Himalayas	22
" " Geographical Survey in Upper Burma	25
" " Topographical Survey of the Indus River	26
" " Forest Survey in Nimar District	32
" " " " in Damoh District	*ib.*
" " " " in Betul District	*ib.*
" " " " in Bombay (N. and C. Circles)	35
" " " " in Bombay (S. Circle)	*ib.*
" " " " in North Arcot District	37
" " " " in South Arcot and Salem District	*ib.*
" " " " in Lower Burma	39
" " Cadastral Survey in Darjeeling District	45
" " " " in Palamau District	48
" " " " in Singhbhum District	49
" " " " in Gaya District	50
" " " " in Patna District	*ib.*
" " " " in Sagaing, Shwebo, etc., Districts	55
" " " in Muzaffarpur District	62
" " " " in Champaran District	65
" " " " in Saran District	66
" " " " in Cachar District	68
" " " " in Amherst and Thaton Districts	70
" " " " in Thaton, Pegu, and Toungoo Districts	*ib.*
" " " " in Minbu and Magwe Districts	73
" " Traverse Survey in Raipur District	76
" " " " in Chanda District	*ib.*
" " " " in Sambalpur District	*ib.*
" " " " in Hoshangabad District	*ib.*
" " " " in Nimar District	*ib.*
" " " " in Bilaspur District	*ib.*
" " " " in Meerut District	79
" " " " in Bahraich District	80
" " Indian Atlas showing sheets published to 1st October 1895	104
" " " " showing work in hand on 1st October 1895	*ib.*



Published under the direction of Colonel C. Strahan, R. E., Surveyor General of India,
February 1896.

No. 357-S. 96.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1894-95.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations of the department that are now reported on are for the survey year ending 30th September 1895.

2. The general administration of the department and the superintendence of the Topographical Branch remained in the hands of Colonel Sir H. R. Thuillier, K.C.I.E., R.E., until the 26th March 1895, on which date he retired from the service, and Colonel C. Strahan, R.E., was appointed to be Surveyor-General. The superintendence of the Revenue Branch and of the Bengal Survey Branch was, at the commencement of the year, in the hands of Colonel W. H. Wilkins, S.C., owing to the absence on privilege leave of Colonel C. Strahan, R.E., Deputy Surveyor-General in charge of the Revenue Branch, and Colonel J. E. Sandeman, S.C., Director of Bengal Surveys. These officers returned to duty and resumed charge of their respective Branches on the 16th October 1894. On the appointment of Colonel C. Strahan to be Surveyor-General in March 1895, Colonel Sandeman was appointed to be Deputy Surveyor-General and to hold charge of the Revenue Branch in addition to his duties as Director of Bengal Surveys. Colonel Sandeman, however, proceeded to England on special leave for six months on the 20th April 1895, and Colonel Wilkins again assumed charge of both offices and held it during the remainder of the year. The superintendence of the Trigonometrical Surveys remained in the hands of Lieutenant-Colonel St. G. C. Gore, R.E., throughout the year, except for a period of two months in January and February 1895, when he was absent on examination leave and the current duties of his office were conducted by Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 1st grade, in addition to his other duties.

Inspection Tours of the Administrative Officers.

3. The Surveyor-General, Colonel Sir Henry Thuillier, left Calcutta on the 1st October 1894 for Dehra Dun, where he inspected the offices of the Trigonometrical Branch and the Forest Survey Branch. From thence he proceeded to Simla where he inspected the Drawing Office of the North-West Trans-Frontier Surveys and the Recess Office of No. 18 Party. He returned to Calcutta on the 21st October 1894. On the 25th April Colonel C. Strahan, R.E., who had succeeded Sir Henry Thuillier as Surveyor-General, left Calcutta and proceeded to Dehra Dun where he inspected the Office of the Superintendent of Trigonometrical Surveys and consulted with that officer on several matters. He also visited the Office of the Superintendent of Forest Surveys. From there he went to Simla where he remained under the orders of the Government of India to be in personal communication with them on the arrangement of the programme, etc. While at Simla he inspected the Drawing Office of the North-West Trans-Frontier Surveys and the Recess Office of No. 18 (Himalaya) Party. He returned to Calcutta on the 24th July. Colonel Strahan again left Calcutta on tour on the

13th August 1895, and proceeded to Bangalore where he inspected the offices of Nos. 11 and 21 Topographical Parties from Upper Burma, and of Nos. 19 and 20 Forest Parties working in Madras and Lower Burma respectively. From Bangalore he went to Poona, where he inspected Nos. 10 Topographical, 17 Forest, 25 Tidal and Levelling Parties. Thence he proceeded *viâ* Bombay to Karachi, where he inspected the Indus River Detachment and consulted with the Commissioner of Sind and the Chief Engineer on the new topographical survey of that province which was to be commenced during the approaching field season. No. 15 Baluchistan Topographical Party was next inspected at Quetta. On the return journey to Calcutta, Dehra Dun and its two offices were again visited, and the parties recessing at Mussoorie were also inspected. The Surveyor-General returned to Calcutta on the 7th October.

4. In December 1894, Colonel C. Strahan, who was then Deputy Surveyor-General in charge of the Revenue Branch, left Calcutta for Silchar where he inspected No. 6 Party which was engaged on cadastral operations in Cachar. Again, in January 1895, he proceeded to Burma where he visited the field camps of Nos. 3, 7 and 12 Cadastral Parties at Mandalay, Moulmein and Yenangyoung respectively, and of No. 20 Topographical Forest Party at Byu. He also interviewed the Chief Commissioner and consulted the Financial Commissioner and the Director of Land Records on the progress of the surveys generally and the programme for the future. He returned to Calcutta on the 16th February.

5. Colonel Sandeman, Director of Bengal Surveys, proceeded to Bihar on a tour of inspection on the 28th October 1894 and returned to Calcutta on the 5th November. He left again for Bihar on the 21st November and remained there travelling about and inspecting the operations in progress until the 22nd December, when he returned to Calcutta. From the 12th to 24th January 1895 he made a tour in Orissa, during which he inspected the Survey Office at Cuttack, the Survey School of the Cuttack College and the instruction classes of the Khurda *sarbarakhars* at Khurda. On the 31st January he left Calcutta for Siliguri, where he was engaged in inspecting field and office work until the 6th February, when he again proceeded to Bihar and started the revision survey of the Darbhanga villages. On the 21st February he reached the Champaran district, and after inspecting both the camps there he returned to the Muzaffarpur district and once more inspected field and office work. On the 8th March he proceeded to the Gaya district and inspected the Tikari Estate traverse survey, and on the 12th arrived at Chaibassa to inspect the Kolhan Estate survey, returning to Calcutta on the 15th.

On the 25th March Colonel Sandeman assumed charge of the Deputy Surveyor-Generalship in addition to his other duties, and was unable to go on tour again, but he inspected the Bengal Drawing Office in Calcutta on the 4th and 5th April.

Colonel Wilkins, who assumed the Directorship of Bengal Surveys when Colonel Sandeman proceeded on leave, in addition to the duties of Deputy Surveyor-General, was unable, owing to press of work at Head-Quarters, to leave Calcutta on inspection duty, but the various operations in progress in Bengal during the remainder of the year were inspected by Captain R. T. Crichton, S.C., from time to time.

6. The Superintendent, Trigonometrical Surveys, proceeded to Simla on the 27th June 1895 to discuss with the Surveyor-General various matters in connection with the administration of his Branch and with topographical procedure. He also inspected the office of No. 18 Party.

After his return to Dehra he went to Mussoorie and inspected the recess offices of the parties under his immediate superintendence, which are located there, *viz.*, Nos. 14 and 24 Parties.

FIELD PARTIES.

7. The field operations of the year under report were carried on by 20 parties (of which two were double parties) and 7 small detachments. Of these, one party was employed on trigonometrical surveys; five parties and three detachments on topographical surveys; four parties on forest surveys; six parties on cadastral surveys; one party and one detachment on traverse surveys;

three parties on scientific operations; and three detachments on geographical surveys. The operations of the small detachments of the Forest Survey Branch, which are now included in this report, were also continued during the year.

The following tabular statement shows collectively the whole of these operations grouped according to the scope and nature of the work on which the parties were severally employed:—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Burma . . .	15	Lieutenant J. M. Burn, R.E.	.....	Supt. Trig.
	Topographical Surveys.				
10	Bombay . . .	16	Lieutenant H. A. D. Fraser, R.E. Lieutenant A. J. Pilcher, R.E.	2″=1 mile for reduction to half scale.	D. S. G. Rev.
11	Upper Burma . .	17	Captain T. F. B. Renny-Tailyour, R.E.	1″=1 mile and ½″=1 mile for reproduction.	Ditto, Topo.
15	Baluchistan . . .	19	Colonel T. H. Holdich, C.B., C.I.E., R.E. Mr. T. E. M. Claudius .	6″=1 mile, 2″=1 mile, 1″=1 mile, ½″=1 mile, ¼″=1 mile and ⅛″=1 mile for reproduction.	Ditto, Topo.
18	Himalayas . . .	21	Lieutenant C. L. Robertson, R.E. Mr. C. D. Potter	4″=1 mile for reduction to ½ scale and reproduction, and 2″=1 mile for reproduction.	Supt. Trig.
21	Upper Burma . .	24	Major F. B. Longe, R.E. . Mr. A. J. Wilson . .	1″=1 mile and ½″=1 mile for reproduction.	D. S. G. Topo.
Det.	Indus River . . .	26	Mr. H. E. T. Keelan . . Mr. G. P. Tate . . .	1″=1 mile for reproduction.	Ditto Rev.
Det.	Orissa	27	Mr. R. C. D. Ewing . .	16″=1 mile for reproduction and 2″=1 mile for reduction to ½ scale.	Director, Bengal Surveys.
Det.	Waziristan . . .	30	Lieutenant-Colonel R. A. Wahab, R.E.	½″=1 mile.	D. S. G. Topo.
	Forest Surveys.				
14	Central Provinces .	31	Captain W. J. Bythell, R.E. Mr. N. C. Gwynne . .	4″=1 mile for reproduction.	Supt. Trig.
17	Bombay . . .	34	Colonel J. R. Hobday, S.C.	16″=1 mile, 8″=1 mile and 4″=1 mile for reproduction.	D. S. G. Topo.
19	Madras . . .	37	Captain H. M. Jackson, R.E. Lieutenant C. H. D. Ryder, R.E.	4″=1 mile for reproduction.	Ditto Topo.
20	Burma . . .	38	Captain P. J. Gordon, S.C.	4″=1 mile and 2″=1 mile for reproduction.	Ditto Rev.
Forest Survey Branch.	Central Provinces .	40	Mr. W. H. Reynolds . .	16″=1 mile and 4″=1 mile for reproduction.	I. G. Forests.
	Punjab . . .	41	Ditto . .	4″=1 mile and 1″=1 mile for reproduction.	Ditto.
	Oudh and North-Western Provinces.	42	Ditto . .	4″=1 mile for reproduction.	Ditto.
	Burma	43	Ditto . .	4″=1 mile for reproduction.	Ditto.
	Cadastral Surveys.				
2 & 8	Bihar and Bengal .	44	Captain G. B. Hodgson, S.C. Captain J. M. Fleming, S.C.	16″=1 mile for reproduction.	Director, Bengal Surveys.
3	Upper Burma . .	54	Mr. G. H. Cooke . .	16″=1 mile and 8″=1 mile for reproduction.	D. S. G. Rev.
4 & 5	Bihar	61	Captain R. T. Crichton, S.C.	16″=1 mile for reproduction.	Director, Bengal Surveys.
6	Assam . . .	68	Mr. E. C. Barrett . . Mr. W. H. Penrose . .	16″=1 mile for reproduction.	D. S. G. Rev.
7	Lower Burma . .	70	Mr C. Wood . . . Mr. W. C. Price . .	16″=1 mile, 2″=1 mile, 1″=1 mile and ½″=1 mile for reproduction.	Ditto Rev.
12	Upper Burma . .	73	Mr. G. H. Cooke . . Mr. B. G. Gilbert-Cooper . Mr. W. S. Buttress . .	16″=1 mile for reproduction.	Ditto Rev.

Statement of Survey Operations and Parties—contd.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Traverse Surveys.				
9	Central Provinces .	75	Mr. E. J. Jackson . . Mr. H. Dowman . .	16″=1 mile (skeleton plots).	Ditto Rev.
Det.	North-Western Provinces and Oudh.	77	Mr. J. S. Pemberton . .	16″=1 mile (skeleton plots).	Ditto Rev.
	Geodetic.				
22	India and Europe .	80	Captain S. G. Burrard, R.E.	.....	Supt. Trig.
23	India and Europe .	80	Captain G. P. Lenox-Conyngham, R.E.	.....	Do. Trig.
	Tidal and Levelling Operations.				
25	India	82	Colonel J. Hill, R.E. . . Lieutenant C. C. D. Morice, R. E. Mr. G. P. Belcham.	.....	D. S. G. Topo.
	Geographical Surveys.				
Det.	Burma and Siam . .	86	Colonel R. G. Woodthorpe, R.E.	½″=1 mile.	Ditto Topo.
Det.	Pamirs . . .	89	Colonel T. H. Holdich, C.B., C.I.E., R.E.	½″=1 mile and ¼″=1 mile.	Ditto Topo.
Det.	Chitral . . .	90	Captain W. J. Bythell, R.E.	4″=1 mile, 1″=1 mile, ½″=1 mile and ¼″=1 mile.	Ditto Topo.

OUTTURN.

8. During the year under report the aggregate area surveyed on all scales amounts to 1,25,384 square miles. This area is exclusive of that embraced by the traverse operations in the Central Provinces and the North-Western Provinces and Oudh, carried on for the purpose of furnishing a basis for field surveys under the Settlement Department, which amounts to 5,018 square miles.

The operations of the various field parties will be found summarised in the following paragraphs, in the order in which they appear in the foregoing statement. A detailed report on the operations of each party for the year under review is given in Part II.

TRIGONOMETRICAL SURVEYS.

9. The Upper Burma principal triangulation was carried northwards as well as westwards through Manipur and Assam. In the former the Mandalay Meridional Series was extended by one quadrilateral figure, over a direct distance of 20 miles, embracing 553 square miles, reaching the parallel of 25° latitude. In Assam and Manipur a longitudinal series was started from the 93° meridian on the parallel of 25°, and carried eastwards over a direct distance of 46 miles, two quadrilateral figures, embracing an area of 805 square miles, being completed, and astronomical observations for azimuth were taken at one station.

The remaining beacons erected last year at the mouths of the Indus were fixed by means of a secondary series of triangles comprising 32 stations of observations and covering a distance of 77 miles. This completes the work of beacon-fixing along the Indus delta.

TOPOGRAPHICAL SURVEYS.

10. During the year under review five parties and three detachments have been engaged on topographical operations. Of these, Nos. 10, 15, and 18 Parties have continued the topographical surveys on various scales upon which they have been engaged for some years past in the Bombay Presidency, Baluchistan, and the Himalayas respectively. The two parties, Nos. 11 and 21, which have hitherto been exclusively employed upon the preliminary geographical survey

of Upper Burma were also engaged during the year on the 1-inch survey of the province, and are now classed as regular topographical parties. The detachment employed during the past two seasons on the survey of the Indus river in Sind completed these operations during the year. The second detachment consisted of that hitherto engaged upon cadastral surveys in Orissa and which, upon the completion of those surveys, was detailed to carry out a topographical survey on the 2-inch scale of the permanently settled portions of the Puri, Cuttack, and Balasore districts during the year under report. The third detachment was organized to accompany the Waziristan Delimitation Commission, and executed an area of 3,680 square miles topographically surveyed on the ½-inch scale.

11. In addition to the topographical work executed by these parties, the detachment with the Pamir Commission surveyed 250 square miles and that with the Chitral Relief Force 215 square miles, both on the ½-inch scale. The operations of these detachments will be found described under the head of Geographical Surveys. Small areas were also topographically surveyed by the cadastral parties in the Katha and Amherst districts, Burma, and by the Forest Survey Branch in the Punjab.

12. The areas topographically surveyed on various scales during the year amount to 21,588 square miles, against 16,072 square miles executed in the previous year.

The total is made up as follows:—

12,563	square	miles	surveyed	on the	½-inch	scale.
4,509	„	„	„	„	1-inch	„
4,112	„	„	„	„	2-inch	„
289	„	„	„	„	4-inch	„
95	„	„	„	„	6-inch	„
20	„	„	„	„	8-inch	„

FOREST SURVEYS.

13. Forest survey operations were continued by the four parties previously employed on this class of surveys in the Central Provinces, the Bombay and Madras Presidencies, and in Lower Burma; and a further small area of forest lands was surveyed by the party working in the Himalayas.

14. In the Central Provinces the detail survey of the forests in the Nimar district was brought to a close, the outturn for the season being 217·6 square miles. In Betul, 351·4 square miles of "B" class forest was completed on the 4-inch scale, and a large area of advance triangulation was completed in districts Betul and Damoh, affording about 800 square miles prepared for final topography. The usual classification of forest growth and soils was carried out over the areas surveyed in detail. Traversing in advance of topography was continued in districts Betul and Damoh, the total length being 1,252 miles. The cost-rate of the survey has been again reduced, being R67·4 per square mile, as against R89 last year.

15. In the Bombay Presidency forest survey operations were continued in the Northern, Central, and Southern Circles, comprising surveys on the 16-inch scale of *babul* reserves in the Poona and Ahmednagar districts; on the 8-inch scale of teak reserves in the North Thana, Poona, and Ahmednagar districts; and on the 4-inch scale of ordinary reserves in the Poona and North Kanara districts.

The total area surveyed amounts to 468 square miles, as against 489 square miles in the previous year. The cost-rates for each class of detail survey are again less than those of the previous year, and Colonel Hobday, the officer in charge of the party, hopes that they may be still further reduced by an increase to the establishment of native surveyors.

16. In the Madras Presidency the survey of forest reserves on the 4-inch scale was continued in the Salem, North Arcot, and South Arcot districts. The area surveyed in detail amounts to 971 square miles, which is the largest outturn yet secured by the party in one year, and 90 square miles in excess of that of last year. The cost-rate of the survey is also proportionately lower. About 1,900 square miles were triangulated, and 850 linear miles of forest boundary were traversed in advance of next season's operations.

17. In Lower Burma the survey on the 4-inch scale of forest reserves in the Hanthawaddy, Pegu, and Shwegyin districts was carried on, the intermediate

unreserved tracts being surveyed, as usual, on the 2-inch scale. The area of detail survey on both scales amounts to 375 square miles, or 51 square miles less than last year. The cost-rate of the detail survey is somewhat higher, owing to the fact that the survey on the 2-inch scale was performed by European agency. The classification of forests and soils of the area surveyed was undertaken by the party for the first time.

18. The party working in the Himalayas surveyed an area of 229 square miles on the 4-inch scale of forest blocks in Kulu, Kangra, Nurpur, and the Simla hill states of Sirmur, Kalsia, and Patiala, in addition to its ordinary operations.

19. The operations of the Forest Survey Branch, which are now incorporated with this report, are under the administration of the Inspector-General of Forests, and supervised by Mr. W. H. Reynolds, Superintendent of the Branch. They were carried on in seven districts of the Central Provinces; in the Bashahr and Chamba states, Punjab; in four districts in the North-Western Provinces and Oudh, and in two districts in Upper and Lower Burma respectively. The aggregate forest area surveyed by the various detachments amounts to 1,616 square miles, of which 146 square miles of exterior forest boundaries were surveyed on the 16-inch scale and 1,470 square miles of forest reserves on the 4-inch scale. In addition, the detachments in Bashahr and Chamba surveyed an area of 282 square miles of non-forest lands on the 1-inch scale to complete the topography of those states. This area has been included under the head of Topographical Surveys. The area surveyed in detail is 178 square miles in excess of that of last year.

20. The total outturn of forest surveys executed on various scales during the year amounts to 4,228 square miles, of which 1,616 square miles was surveyed by the Forest Survey Branch. The area surveyed by the Imperial survey parties, *viz.*, 2,612 square miles, is 90 square miles in excess of that surveyed during the previous year by the same parties.

The areas on the different scales are as follows:—

36	square	miles	surveyed	on	the	2-inch scale.
3,737	„	„	„	„	4-inch	„
285	„	„	„	„	8-inch	„
170	„	„	„	„	16-inch	„

CADASTRAL SURVEYS.

21. The number of parties engaged on cadastral operations during the year has been as follows: Two double parties in Bengal, three parties in Burma, and one party in Assam.

22. In the Bengal Province the parties were engaged, in continuation of the work of previous years, in the cadastral survey and preparation of the record-of-rights in temporarily-settled tracts and in Government and private estates. The principal operations of the year were in the Muzaffarpur and Champaran districts of North Bihar; in the Darjeeling district; in the Government estate in Palamau, and in the Government estates and the Tikari Ward's estate in the Gaya district.

23. The following is a summary of the progress of work in each district in which the larger surveys were carried on.

In Muzaffarpur an area of 658 square miles was cadastrally surveyed, and the records were written of an area of 938 square miles. The cost-rates for these operations were R55·5 and R83·8 respectively. The area surveyed in previous seasons in this district amounted to 1,508 square miles and about 834 square miles remains to complete the district. In addition to the regular cadastral operations, the revision was undertaken of an area of 410 square miles surveyed by Colonel Barron in 1885-86, and of a small area surveyed under the supervision of Mr. Finucane in 1878-79.

In the Champaran district the areas of cadastral survey and record-writing were 1,162 and 1,176 square miles, respectively, and the area traversed in advance was 126 square miles, which comprises all the remainder of the cultivated portion of the district. The total area surveyed during this and previous seasons amounts to 2,095 square miles, which leaves about 1,436 square miles remaining for survey. The cost-rates of the survey and record-writing were R65·6 and R68·4, respectively, and of the traverse survey R59·8.

In the Saran district traverse survey alone was carried on, the cadastral survey being suspended until the Champaran district is completed. The area traversed was 516 square miles, and the cost-rate was ₹27·1.

In the Darjeeling district a re-survey on the 16-inch scale of the *jotes* in the Terai was undertaken, the settlement made in 1877-79 being about to expire. The area surveyed cadastrally with record-of-rights amounted to 210 square miles, and the cost-rates were, for cadastral survey, ₹150·3, and for record-writing ₹39·4.

The survey and record-writing of the Palamau Government estate was carried on in continuation of the work of the two previous seasons. The area surveyed was 162 square miles, and the records of this area were written. The survey of the cultivated portions of the estate have now been completed. The cost-rates were, for survey ₹80·5, and for record-writing ₹56.

The Kolhan Government estate, in district Singhbhum, was traversed during the year, the area, which comprises the whole estate, being 1,175 square miles. The cadastral survey is to be undertaken next season. The cost-rate of the traversing is ₹30·6.

The survey and record-writing of the Government estates in district Gaya was also undertaken during the year, the area, which lay in two main blocks and various scattered villages, amounting to 89 square miles cadastrally surveyed with records. The cost-rates were for survey ₹109·2, and for records Rs. 67·7.

The cadastral operations in the Tikari Wards' Estate, Gaya and Patna districts were continued during the year, the area surveyed being 16 square miles, and that of record-writing 64 square miles. In addition, a revision survey on the 32-inch scale, with records, of seven villages, having an area of 1·7 square miles, was carried out, and also the boundary survey of 40 *mukarrari* villages (held on fixed and permanent lease), having an area of 20 square miles. No cost-rates are given for the survey in this estate, as the greater part of the expenditure was incurred in the completion of arrears, the area of new survey being very small.

The survey and record-writing of the Chaurasi estates, district 24-Parganas, which was commenced in the previous season, was completed during the year under report. The area of cadastral survey and record-writing was 33 square miles, and the cost-rates ₹108 and ₹78 respectively.

Eight villages comprising the Tantibunia estate, district Khulna, were surveyed cadastrally, with record-of-rights, the area being 20 square miles, and the cost-rates ₹107·2 for the survey, and ₹38·7 for the records.

In Orissa the few scattered villages remaining for survey in districts Cuttack and Balasore were completed, the area being 5·5 square miles. This completes the survey of the temporarily settled portions of the Orissa Division.

24. The three parties which, for several past seasons, have been employed on cadastral surveys in the Burma Province, continued these operations during the year under report, No. 7 Party working in Lower Burma and Nos. 3 and 12 Parties in Upper Burma. The operations in Lower Burma comprised cadastral surveys in districts Amherst (which was completed during the year), Pegu and Thaton. The total area cadastrally surveyed amounted to 1,034 square miles, of which 611 square miles were in Amherst and 423 in Pegu and Thaton. About 1,000 square miles of advance traverse was prepared in the three districts. The cost-rates of the cadastral survey, irrespective of the proportion of cultivation to jungle, are ₹92·1 in Amherst and Thaton, and ₹128·2 in Pegu. In addition to the above work, the topographical survey of 187 square miles on the 2-inch and 1-inch scales, and the reconnaissance of 30 square miles on the $\frac{1}{4}$-inch scale was carried out by this party to complete gaps in the topographical maps. The number of Burmans and Karens employed was exactly the same as last year, *viz.*, 36, of whom 14 had been entertained under Mr. Bridge's scheme, the operation of which is now closed. The average outturn of work of the Burmans was about three-fourths that of the Hindustanis.

25. In Upper Burma, the work of No. 3 Party was again scattered over a wide area, lying in six districts. The season's outturn of cadastral survey comprised 1,002 square miles in Yamethin, 95 square miles in Meiktila, 150 square miles in Upper Chindwin, 163 square miles in Katha, and 239 square miles in Yeu and Shwebo, or a total area of 1,649 square miles surveyed on the

16-inch scale. An area of 5 square miles of grants in the gold fields in Katha was also surveyed on the 8-inch scale. The holding-marking, writing of records, and register of crops of the greater part of the cadastral area was also performed. The average cost-rate per square mile for the six districts is ₹151 for cadastral survey and ₹17·7 for the records. No difficulty was experienced in obtaining local labour during the season. It is believed that eventually there will be no need to import any except trained hands from India, and that a considerable diminution in cost-rates will be effected.

26. No. 12 Party completed the cadastral survey of the Magwe district and commenced that of the Myingyan district. The area surveyed in the former district amounted to 897 square miles, while in the latter only 8 square miles were completed. An area of 908 square miles of advance traverse was also prepared in Myingyan. The cost-rate of the cadastral survey, including records, in Magwe was ₹148·6, and that of the traverse survey in Myingyan was ₹52·6. The number of Burmans employed during the season was 38, or the same as in the preceding season, while the number of field surveyors imported from India was 81. The average monthly outturn of the Burmans was rather better than last year, being about seven-eighths that of the Indians. As it has been decided that only one cadastral party will in future be required in Upper Burma, this party was, at the close of the year, transferred to the Bombay Presidency, where it will undertake the topographical survey of the Sind province.

27. In Assam, No. 6 Party continued traverse and cadastral operations in the Cachar district, and completed an area of 540 square miles of cadastral survey and 510 square miles of advance traverse. About 200 square miles of traverse and 400 square miles of cadastral survey remains to complete the area allotted for survey in the district. The cost-rate of the combined operations, including traverse, detail survey, mapping and completion of records, is ₹133·2, which is considerably lower than the rate for the previous season, owing mainly to the larger area surveyed.

28. The areas of cadastral survey completed during the year in the different provinces are as follows :—

	Square miles.
Bengal	2,806
Burma	3,588
Assam	540
TOTAL	6,934

This outturn shows a decrease of 1,346 square miles, as compared with that of last year, when two additional cadastral detachments (*viz.*, those employed in Orissa and Garhwal, the operations of which have been completed) were at work.

TRAVERSE SURVEYS.

29. One party and one detachment were employed during the year on these surveys, the object of which is to furnish a skeleton basis for settlement surveys by local agency. In the Central Provinces, No. 9 Party continued its operations and was employed in districts Raipur, Chanda, Sambalpur, Hoshangabad, Nimar and Bilaspur, on the boundaries of scattered villages in *Zamindári* estates and of forest blocks. The total area traversed amounted to 1,892 square miles, of which 489 lay in Raipur, 719 in Chanda, 528 in Sambalpur, 29 in Hoshangabad, 81 in Nimar and 46 in Bilaspur. The 16-inch skeleton plots of the whole area were supplied to the Settlement Department during the year. The cost-rate of the traversing amounted to ₹39·2 per square mile, which is considerably higher than that of the previous season, when, however, the programme of operations was a much more extended one and the outturn much larger. The party is to be retained for another season in the Central Provinces to traverse a number of scattered villages remaining in the Raipur, Chanda, Sambalpur and Bilaspur districts, and also certain scattered areas of forest lands, about 200 square miles in extent, which are to be excised from the forests for *raiyatwari* settlement.

30. One of the traverse sections attached to the Bihar cadastral parties was transferred as a separate detachment to the North-Western Provinces and

Oudh, where it commenced traverse operations in the Meerut and Bahraich districts; its object was to supply the plots on which the cadastral survey was to be made by local agency, supervised by Provincial officers of the Survey Department. The total area traversed was 3,126 square miles, of which 1,787 lay in Meerut and 1,339 in Bahraich; and the cost-rate per square mile was R21·3.

31. The areas which have been thus traversed during the year, exclusive of the preliminary traversing connected with the cadastral surveys done by this Department, are as follows:—

	Square miles.
Central Provinces	1,892
North-Western Provinces and Oudh	3,126
TOTAL	5,018

SPECIAL OPERATIONS.

32. The two astronomical parties under Captains Burrard and Lenox-Conyngham have been engaged throughout the year in the determination, by the electro-telegraphic method, of the difference of longitude between Greenwich and Karachi. The work is one of considerable magnitude and is still in course of execution. Commencing at Karachi, arcs of longitude were successfully measured between Karachi, Jask and Bushire; the scene of operations was then changed to Europe and the arc Greenwich-Potsdam completed. It is calculated that the observing operations will be concluded by April next, and there will then only remain the reduction and discussion of the observations to complete the work.

33. The tidal operations have been continued as usual. Observations with the self-registering tide gauges have been made at thirteen stations in India, Burma, the Persian Gulf, Ceylon, the Andaman Islands and Minicoy. No tidal observatories were closed during the year. The permanent observations were resumed at Madras in December 1894 and the minor station at Diamond Island was established during the same month.

34. In connection with the tidal operations, spirit-levelling was carried on in a direct line from Cuttack down the coast *vid* Khurda and Ganjam to Berhampore and thence along the East Coast Railway to Vizagapatam, thus effecting a connection with the spirit-levelling that was brought northwards to Vizagapatam in 1887-88, and completing the junction by spirit-levelling of all the tidal stations along the east coast of India. A branch line was carried from Khurda to Puri as a basis for the rectification of the railway levels and to determine the height of points in Puri. In addition to the above a short line was run to connect the standard bench-mark for Calcutta with the Kidderpore tidal observatory.

The total outturn amounts to 356·5 miles of double levelling, fixing one standard bench-mark, 37 ordinary embedded bench-marks, 365 ordinary inscribed bench-marks, 7 bench-marks of reference of tidal observatories, 31 railway bench-marks and 4 stations of the Great Trigonometrical Survey.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

35. A large area has been geographically surveyed on the $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales during the year, the greater part of which was again furnished by the native surveyors of No 15 Party, working independently in Persia and Arabia. The geographical area in Upper Burma is larger than last year, as, in addition to the areas obtained by the two topographical parties on the $\frac{1}{4}$-inch scale, a further considerable area was contributed by the detachment with the Mekong Mission.

36. In Upper Burma No. 11 Party obtained an area of 2,156 square miles surveyed on the $\frac{1}{4}$-inch scale, consisting chiefly of a portion of the Keng Tung State not hitherto surveyed. The area surveyed on the same scale by No. 21 Party amounted to 10,247 square miles, of which 6,167 square miles was obtained by Major Longe and a small detachment which visited the Kokang state, to be ceded to China under the Anglo-Chinese Convention. The native surveyor employed on the demarcation of the Burma-Siam boundary secured an area of 1,726 square miles of $\frac{1}{4}$-inch reconnaissance. The remaining area of

2,354 square miles was surveyed in the Northern Shan States and the Upper Chindwin district by other native surveyors of the party to complete the preliminary geographical survey of those parts.

37. The Mekong Mission of enquiry into the proposed limits of the buffer state on the Mekong river, under Colonel Woodthorpe, R.E., secured an area of 4,928 square miles of fairly accurate topography on the $\frac{1}{4}$-inch scale, comprising the whole of the buffer state. The whole area was triangulated, and a satisfactory junction was effected with Mr. McCarthy's triangulation of Siam. The positions of all the principal places visited by the Mission were laid down.

38. On the North-West frontier the principal geographical work done was in Persia, the Perso-Baluch frontier, and Arabia, by native surveyors of No. 15 Party. Khan Bahadur Sheik Mohiuddin alone reconnoitred about 45,000 square miles of new country on the $\frac{1}{8}$-inch scale in Western Baluchistan and Persia. This work has been separately reported on. Khan Bahadur Yusaf Sharif, with an assistant, succeeded in mapping about 19,000 square miles on the $\frac{1}{8}$-inch scale between Bandar Abbas and Jask. In Arabia a reconnaissance of about 3,000 square miles was effected by Khan Bahadur Imam Sharif who again accompanied Mr. Theodore Bent on his tour of exploration. The geographical outturn of the various detachments furnished by No. 15 Party to accompany the Indo and Baluch-Afghan Boundary Commissions amounted to 1,570 square miles; the greater part of the work of these detachments was done on the 2-inch, 1-inch and $\frac{1}{2}$-inch scales, and is included under the head of Topographical Surveys.

The detachment under Colonel Holdich, which accompanied the Pamir Delimitation Commission in June 1895, surveyed an area of 4,800 square miles on the $\frac{1}{4}$-inch scale. About 40 points and peaks were fixed by triangulation, the series being successfully carried from the Darkot Pass to the Pamir, when a very satisfactory junction was effected with the work of the Russian party.

The Chitral Relief Force was accompanied by a detachment under Captain Bythell. The results comprised an area of 1,900 square miles surveyed on the $\frac{1}{4}$-inch scale, 90 linear miles of traverse surveys, and a series of triangles extending from Hoti Mardan to the Laorai Pass. Large scale plans were also made of the various camps occupied by the force. For his good services in connection with this work Captain Bythell has since received a Brevet majority.

39. The aggregate areas geographically surveyed during the year on the Eastern and Western frontiers amount to 92,600 square miles.

HEAD-QUARTER'S OFFICES.

40. The details of the work done at the various offices at the head-quarters are given in Part III of this report.

41. The offices located in Calcutta were, as usual, supervised by three Assistant Surveyor-Generals. The Drawing and Engraving Offices were under the supervision of Mr. G. B. Gilbert-Cooper for the first two months of the year, and then for one month under that of Mr. T. A. Pope, who was relieved by Colonel W. H. Wilkins, S.C., the permanent incumbent, at the end of December 1894, on the return of that officer from privilege leave. In April 1895, on the appointment of Colonel Wilkins to officiate as Deputy Surveyor-General, the charge of these offices devolved upon Mr. C. F. Erskine, who held it during the remainder of the year. Colonel J. Waterhouse, S.C., continued to hold charge of the Photographic and Lithographic office during the year. The charge of the Correspondence and Mathematical Instrument Offices continued in the hands of Colonel M. W. Rogers, R.E., until March 1895, when he proceeded on furlough, and Mr. T. A. Pope assumed charge for the remainder of the year. The Bengal Provincial Drawing Office was supervised by Captain J. M. Fleming, S.C., until June 1895, and thereafter by Captain G. B. Hodgson, S.C.

42. The Drawing Office has continued to be chiefly engaged with the compilation of the maps of Burma on various scales. Six sheets of the North-East and South-East Frontier series on the 4-mile scale have been in different stages of progress, two of which have been published; whilst eight maps of the same series, on the 8-mile scale, have been in progress and are well advanced.

The compilation of the second edition of the map of Burma on the 16-mile scale, referred to in paragragh 43 of last year's annual report as nearly ready for publication, has been published during the year under report, with numerous additions and corrections; and the 16-mile map of the Punjab has been completed with hills and printed in two colours. The third edition of the map of India on the 32-mile scale still awaits the orders of Government in respect of frontier boundaries. In addition to the above, a large number of the sheets of the Atlas of India were in hand with additions and corrections to either hill drawing or outline.

43. The Bengal Provincial Drawing Office was engaged, as usual, on the compilation of standard quarter-sheets on the 2-inch scale, for reduction by photography to the 1-inch scale, of the maps prepared by the cadastral parties working in the Western Duars, Orissa, and Bihar. All arrears of work on the sheets of the Western Duars were completed, and very satisfactory progress was made with those of Orissa and Bihar.

44. In the Engraving Office, the preparation of the quarter-sheets of the Atlas of India was steadily pushed on, 7 new plates having been completed and published during the year, and 103 others being in various stages of progress. Ten district maps for Administration Reports were completed and thirty-nine more were in hand. The six sheets of the 32-mile map of India, without hills, have been completed as far as reliable material is available, while that on the 128-mile scale was almost completed. A new 80-mile railway map of India was started and is well advanced in outline. Of provincial maps, those of Bombay and Madras Presidencies, of Gujarat, Punjab and Kashmir, and of Mysore and Coorg on the 16-mile scale, have all been in hand, and made good progress. Two index maps and a map of Bengal on the 64-mile scale were also completed. The new plates of the map of the City of Calcutta on the 16-inch scale have been nearly completed, and the map will be ready for publication early in the ensuing year.

45. In the Photographic and Lithographic Office the number of subjects received again shows a falling off, especially in sheets of the cadastral survey, but there has been an increase in the number of subjects received from other departments. The total number of original maps and drawings in hand was 5,908, of which 793 were departmental, 3,859 were cadastral maps of North-Western Provinces, Assam, and Burma, and 1,256 were miscellaneous subjects from other departments. The total value of the work done for other departments was ₹76,534, which shows an increase of ₹5,393 over last year.

The outturn of the lithographic and zincographic presses and machines was 894,286, which is very much less than last year. The decrease is entirely due to the smaller number of departmental maps, both normal and cadastral, under reproduction. The work of the presses, etc., comprised 1,291,041 impressions from type, 49,675 heliogravure prints, and 3,820 silver prints and blue prints. The total value of the work done was about ₹2,06,926.

There have been no important new publications during the year. The issue of the third edition of the 32-mile map of India is still delayed, pending the settlement of frontier boundaries, but further new material has been added. The 24-mile map of Afghanistan which is being chromo-lithographed in three colours, as reported last year, is also in abeyance, pending the final settlement of boundaries and also the addition of new information in the direction of Chitral and the Pamirs.

A new edition of the skeleton 64-mile map of India, showing provincial and district boundaries, has been issued; also 70 standard maps of the topographical and revenue surveys on various scales; maps of districts Gorakhpur and Almora on the 2-mile scale and of districts Kamrup, Mymensingh, Sonthal Parganas, Lohardugga, Burdwan, Malda, Darbhanga, Cachar, and Sylhet on the 4-mile scale. The printing of the sheets of the new survey of Calcutta on the 50-feet scale was completed, and several sheets have been reprinted; a map of Calcutta and suburbs on the 3-inch scale was reproduced. A re-issue of the plan of Mysore City, with additions, has been published; also plans of Belgaum and Rawal Pindi and environs. Thirty-eight sheets of the Forest surveys in Madras were printed off.

The extra-departmental work has been of its usual varied character. The printing off of several subjects commenced last year or earlier was completed; among them maps for the new Statistical Atlas, the geological map of Hazara,

the Bower manuscripts, and a plan of the City of Amritsar. Nine sheets of the survey of George Town, Penang, were printed off, and 32 sheets of the large scale survey were received for reproduction. Thirteen maps in English and Siamese were reproduced for the Royal Survey Office of the Government of Siam.

Instruction in photo-zincography and other processes worked in the office was given to Mr. H. V. L. Nicolay of the Royal Survey Department, Siam, and to Sub-Conductor Maher of the Fatehghar Gun Carriage Agency.

The outturn of the Heliogravure Section, though rather less than last year, is well up to the average; 85 plates were photo-etched, including 11 plates of the technical art series; 12 plates illustrating the zoology of the R. I. M. S. *Investigator*; 5 plates illustrating the report of the Medical Congress; and 8 views of the Gohna Lake. The frontispiece to this report is a photo-etching of a portrait of Colonel Sir H. R. Thuillier, K.C.I E., R.E, the late Surveyor-General, reduced from a negative by Messrs. Bourne and Shepherd. Considerable progress has been made in working out the new half-tone photo-block processes, though photo-etching is found more suitable for most of the purposes of the office.

46. In the Map Record Office, the number of new maps and new editions of departmental subjects received during the year amounted to 4,414, of which 3,981 were cadastral maps. The total number of maps issued was 234,226 and their value ₹1,10,956. The issues show a decrease on those of the previous year of 55,681, owing to smaller demands both by Government officials and private individuals and the value of the maps issued is less by ₹53,941. The cash sales of maps amounted to ₹23,339, or an increase of ₹143 over the cash sales of the previous year.

47. In the Mathematical Instrument Office there has been a slight increase in the demands for scientific instruments over those of the preceding year. The total number of instruments issued was 71,875, against 63,728 last year. The total value of the issues was, however, ₹2,40,818, against ₹2,47,111 last year, or a decrease in value of ₹6,293. The outturn of repairs done to instruments is greater than in any previous year. The number of serviceable instruments received into store during the year was 88,591, valued at ₹3,80,703; that of repairable instruments received was ₹9,062, and their value ₹66,198.

48. During the year the alterations to the office buildings of the Trigonometrical Branch were commenced by the Public Works Department and nearly finished. The computations for the Synoptical volume of the North-East Longitudinal Series were proceeded with. The field records of the Municipality survey of the towns of Gurgaon and Sohna were reduced, and plots supplied to the Deputy Commissioner of Gurgaon. Instruments and data were supplied to the Survey Detachments to accompany the Chitral Relief Force, the Pamir Delimitation Commission and the Anglo-Afghan Boundary Commissions. All arrears of map printing were cleared off, and a large order in connection with the late frontier expedition was met with promptitude. Some compilation was done in the Drawing Section. The work proceeded satisfactorily considering how small the accommodation was in consequence of the repairs to the buildings.

49. In the Simla Drawing Office the principal work of the year has been the preparation of second editions of the 8-mile sheets of the North-West Trans-Frontier and South-West Asia Series by incorporating with the first editions the new matter furnished by officers of the Intelligence Branch and others which has been steadily accumulating for some time past. Twelve of these sheets were completed and sent to press, and several others were in progress. Satisfactory progress was also made with the 16-mile map of Persia and a good deal of miscellaneous work of various kinds passed through the office.

50. The head-quarter office of the Forest Survey Branch at Dehra Dun was engaged throughout the year upon the maintenance of forest records; the final computations of the several field detachments and areas; the compiling and drawing of special maps for the Forest Department; the training of surveyors in forest survey work, besides other miscellaneous work for the Forest Department. The mapping work included 15 special maps on various scales published, and four sent to press, while 18 more were in progress. Of the 4-inch standard maps of forest tracts, 127 sheets were published, 45 were sent to press, and 118 sheets were in various stages of progress.

ESTABLISHMENT.

51. During the year the Government of India sanctioned the re-organisation of the Department into an Imperial, a Provincial, and a Subordinate Service with effect from the 27th March 1895. The new scheme provides for the transfer of ten appointments from the old Senior Division to the Provincial Service, the remainder of that division, together with the administrative appointments at the head of the department, constituting the Imperial Service. The transfers are, however, to be made gradually, commencing with the three vacancies in the 2nd grade of Assistant Superintendents, the remaining seven appointments to be transferred from time to time as those three appointments rise into the grades above. Of the ten appointments transferred, five are to form new posts at the head of the Provincial Service List, and to be designated Extra Deputy Superintendents, 1st and 2nd grade. The other five are distributed among the grades of extra Assistant Superintendents. No change was made in the constitution of the Subordinate Service.

52. During the year the Department has lost the services of three officers of the Imperial List.

Colonel Sir H. R. Thuillier, K.C.I.E., R.E., retired on the 26th March 1895, after a service of 36 years in the Department, during the last nine of which he controlled it as Surveyor-General. Colonel Thuillier joined the Department in May 1859 and was posted to the Trigonometrical Branch, in which he served until the amalgamation of the branches in 1878. During this period he held charge of the trigonometrical parties engaged on the Calcutta Longitudinal and Brahmaputra Series; the Kumaon and Garhwal Topographical Survey; the Dehra Dun and Jaunsar Bhawar Surveys; and lastly of the Mysore Topographical Survey which he held for several years. In October 1883 Colonel Thuillier was appointed to officiate as Deputy Surveyor-General in charge, Revenue Branch, and a year later was confirmed in that post and appointed to officiate as Surveyor-General of India. On the death of Colonel De Pree in 1887 he was confirmed in this appointment and held it until his retirement. The Government of India have been pleased to record their appreciation of the good service which Sir Henry Thuillier has rendered.

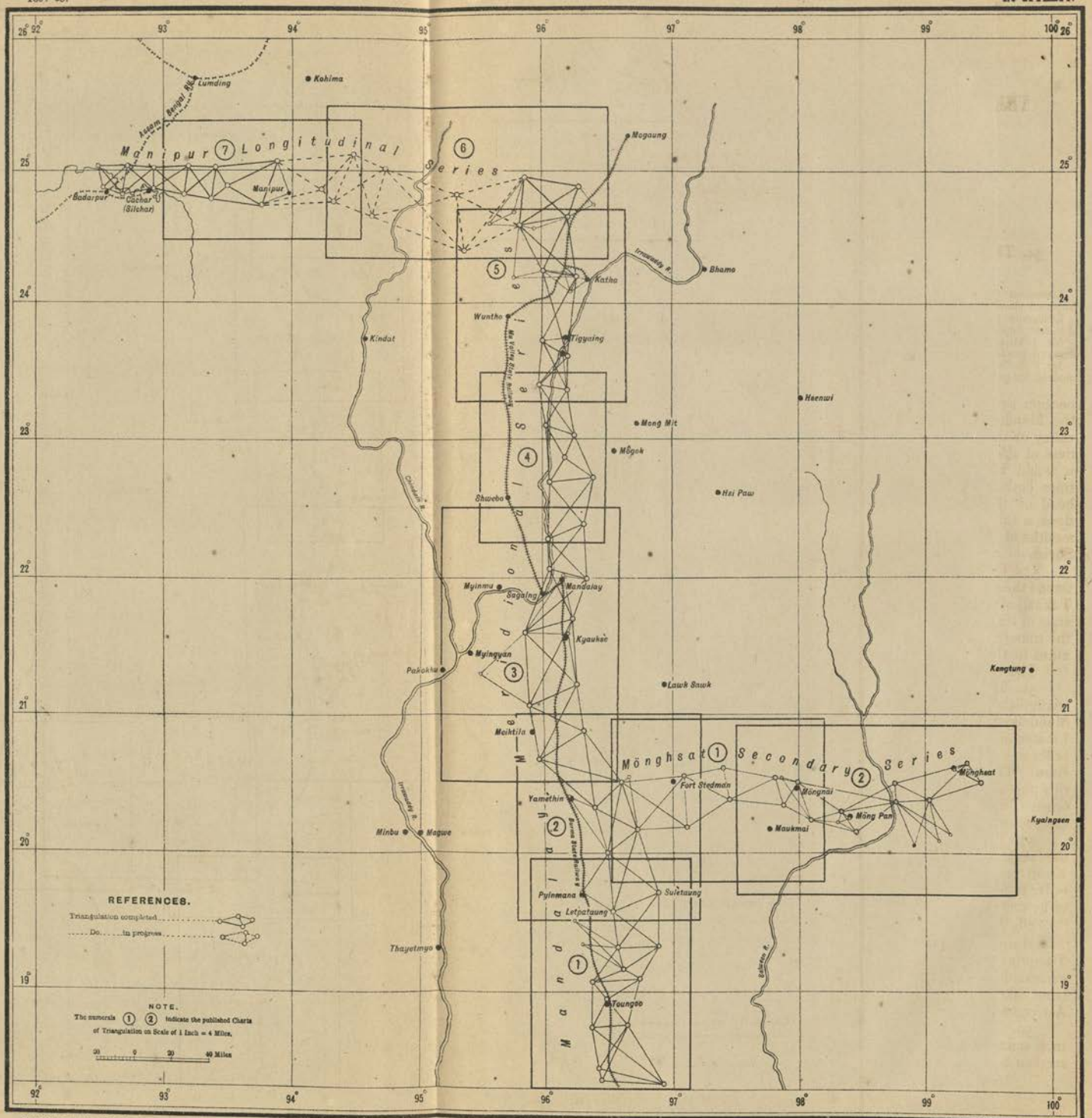
Colonel J. R. McCullagh, R.E., Superintendent, 2nd grade, retired on the 1st January 1895, after having served in the Department for 26 years. He was appointed originally to the Trigonometrical Branch, in which he served until 1875 when he was transferred to the Topographical Branch in which he remained during the rest of his service, with the exception of a few years, during which he held charge of a Cadastral Survey party in Burma. Colonel McCullagh rendered valuable service, and the loss of his varied experience is regretted.

Lieutenant P. J. F. Macaulay, R.E., Assistant Superintendent, 2nd grade, who was attached to the survey party with the Waziristan Delimitation Commission, was killed in action on the 3rd November 1894, during the Mahsud-Waziri attack on the British camp in the Wana Valley. Lieutenant Macaulay had only been appointed to the Department eight months previously, but had given evidence of much promise, and the officers under whom he served had formed the highest opinion of his character and devotion to duty. The Government of India have been pleased to concur in this opinion and to convey an expression of their regret at his loss.

53. Six vacancies have occurred in the Provincial List during the year, *viz.*, four by the deaths of Messrs. H. E. T. Keelan, C. W. F. Seyers, D. Campbel and T. J. J. Mills, and two by the deputation of officers to the Provincial Service of the North-Western Provinces and Oudh.

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION
OF THE
MANDALAY MERIDIONAL AND MANIPUR LONGITUDINAL SERIES.

1894-95. No. 24 PARTY.



Reg. No 477. S. I. D.—Nov. 95—500

Photo., S. I. O., Calcutta.

No. 523-S. 95.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL AND SECONDARY TRIANGULATION.

BURMA AND THE INDUS DELTA COAST.

No. 24 Party.

54. The selection of stations for the Mandalay Meridional Series, the backbone of principal triangulation running north and south through Burma, having been completed as far north as is feasible at present, there remained to complete this series merely the observation of the angles of the last figure. To complete the final computations and adjustment of the Burma triangulation it is necesary to make a connection across from old triangulation in Assam to the most northerly points of the Mandalay Series. As the work of carrying the triangulation across the valley of the Chindwin river would clearly be most difficult, owing to the denseness of the forest and the almost entire absence of hills, it was decided that it would be most economical to divide the party and commence the connection from both ends, one working from Cachar eastwards and the other from the head of the Mandalay Meridional Series westwards. This was accordingly done, a third small section being detached to complete the triangulation at the mouths of the Indus, where beacons are being erected for the use of the Marine Survey.

Personnel.

Lieutenant J. M. Burn, R.E., Assistant Superintendant, 1st grade, in charge.
Lieutenant A. J. Pilcher, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. J. Hickie, Extra Assistant Superintendent, 5th grade.
Mr. P. F. Prunty, Extra Assistant Superintendent, 6th grade.

55. The first section, under the direct control of Lieutenant Burn, continued the principal triangulation from the most eastern stations, Ramphan and Tukbai, of the old Cachar Branch Series, which series was left in an unfinished state in 1862, owing to the wild nature of the country further east. This season the triangulation was carried across the Naga Hills of Western Manipur some 50 miles to the east, and the position of Manipur town definitely fixed.

The series will now be called the Manipur Longitudinal Series.

56. The second section under Lieutenant Pilcher carried the principal triangulation in Upper Burma one more figure to the north, thus bringing the Mandalay Meridional Series up to about the latitude of 25°. From this point Lieutenant Pilcher and his party prospected for stations towards the west, in order to connect with the triangulation being carried eastwards by Lieutenant Burn. The very greatest difficulty was, as had been anticipated, experienced at this point, owing to the dense nature of the jungle, the want of suitable hills for Great Trigonometrical stations and the almost entire absence of villages in the country traversed.

57. The Indus Delta coast section under Mr. Prunty continued and finished the work of erecting and fixing the positions of beacons from Karachi to the Khori creek in Cutch, some 150 miles along the coast to the south-east, in order to furnish points at convenient intervals, as a basis for the coast survey to be undertaken by the Marine Survey Department.

58. The season's outturn of the first two sections is as follows :—

Horizontal and vertical angles have been taken at eleven principal stations. The principal series have been extended over a direct distance of some 70 miles, embracing an area of 1,350 square miles. Horizontal and vertical angles have been taken at two secondary stations, embracing an area of 400 square miles. Astronomical observations for azimuth were taken at one station.

59. The principal observations were taken with Troughton and Simms' 12-inch micrometer theodolites, Nos. 1 and 2, Lieutenant Burn using No. 1. The method of observing was to measure angles on nine zeros, two faces on each

zero, and two swings on each face. The mean combined triangular error (including some angles measured by Lieutenant Burn last season) which ranged from 0·025″ to 1·679″, is 0·96″. The computation of three figures (two quadrilaterals and one tetragon) has been completed.

60. The season's outturn of the Indus Delta coast section is as follows:—One beacon was re-erected and the positions of thirteen fixed, extending south-eastwards some 80 miles from where the season's work ended last year.

This work is now completed.

61. The observations of the Indus Delta coast section were taken with a 12-inch vernier theodolite, on two zeros, two faces on each zero, and two swings on each face. The mean triangular error is 10·5 seconds.

62. The first two sections left the field at the end of May 1895, the third section at the beginning of March, for recess quarters at Mussoorie.

63. The health of the section under Lieutenant Burn was, on the whole, wonderfully good, but that of the section under Lieutenant Pilcher was not so. Malaria and dysentery attacked his men most severely at the commencement of the season, and at times there were few men left fit for work. Mr. Prunty's men suffered severely from fever in the Indus Delta.

64. Statements, showing the details, respectively, of the outturns of the Manipur, Upper Burma, and Indus Delta sections, and one showing the results of astronomical observations for azimuth of the Mandalay Meridional Series will be found at pages i to iii of the appendix.*

TOPOGRAPHICAL SURVEYS.

SOUTHERN MARATHA COUNTRY.

No. 10 Party.

65. This party remained in the charge of Lieutenant Fraser, R.E., until the 6th August 1895, when he was transferred to No. 24 Party and the charge devolved temporarily upon Mr. A. J. Gibson. Lieutenant Pilcher, R.E., assumed the charge from Mr. Gibson on the 3rd September 1895.

Personnel.

Lieutenant H. A. Denholm Fraser, R.E., Assistant Superintendent, 1st grade, in charge up to 6th August 1895.
Lieutenant A. J. Pilcher, R. E., Assistant Superintendent, 1st grade, in charge from 3rd September 1895.
Mr. A. J. Gibson, Extra Assistant Superintendent, 1st grade, in charge from 6th August to 3rd September 1895.
„ A. G. Wyatt, Extra Assistant Superintendent, 2nd grade.
„ R. R. Dickinson, Extra Assistant Superintendent, 6th grade.
„ G. A. Knight, Extra Assistant Suparintendent of the 6th grade.
„ J. A. Freeman, Sub-Assistant Superintendent, 3rd grade.
37 surveyors, sub-surveyors and others.

66. The party left Poona about the middle of November 1894 and returned to recess quarters between the 31st May and the 12th June 1895.

67. The season's operations were in continuation of those of the previous season, *viz.*, the topographical survey on the 2-inch scale of the Southern Maratha country and the Konkan. The detail survey was contained in sheets Nos. 301, 302, 327, 329 and the western part of No. 349, and comprised portions of the Belgaum and Bijapur districts and the Kolhapur and Satara Agencies. In addition to this, a plan of Dharwar city was executed on the 8-inch scale.

The survey of the Goa territory had to be abandoned owing to the refusal of the Portuguese Government to sanction it.

68. The whole of the triangulation remaining to be done by the party was completed during the season. It includes those portions of sheets Nos. 350 and 351 which fall in British territory and also the revision of the triangulation in sheets Nos. 328, 329.

69. The total outturn of work for the season is as follows:—

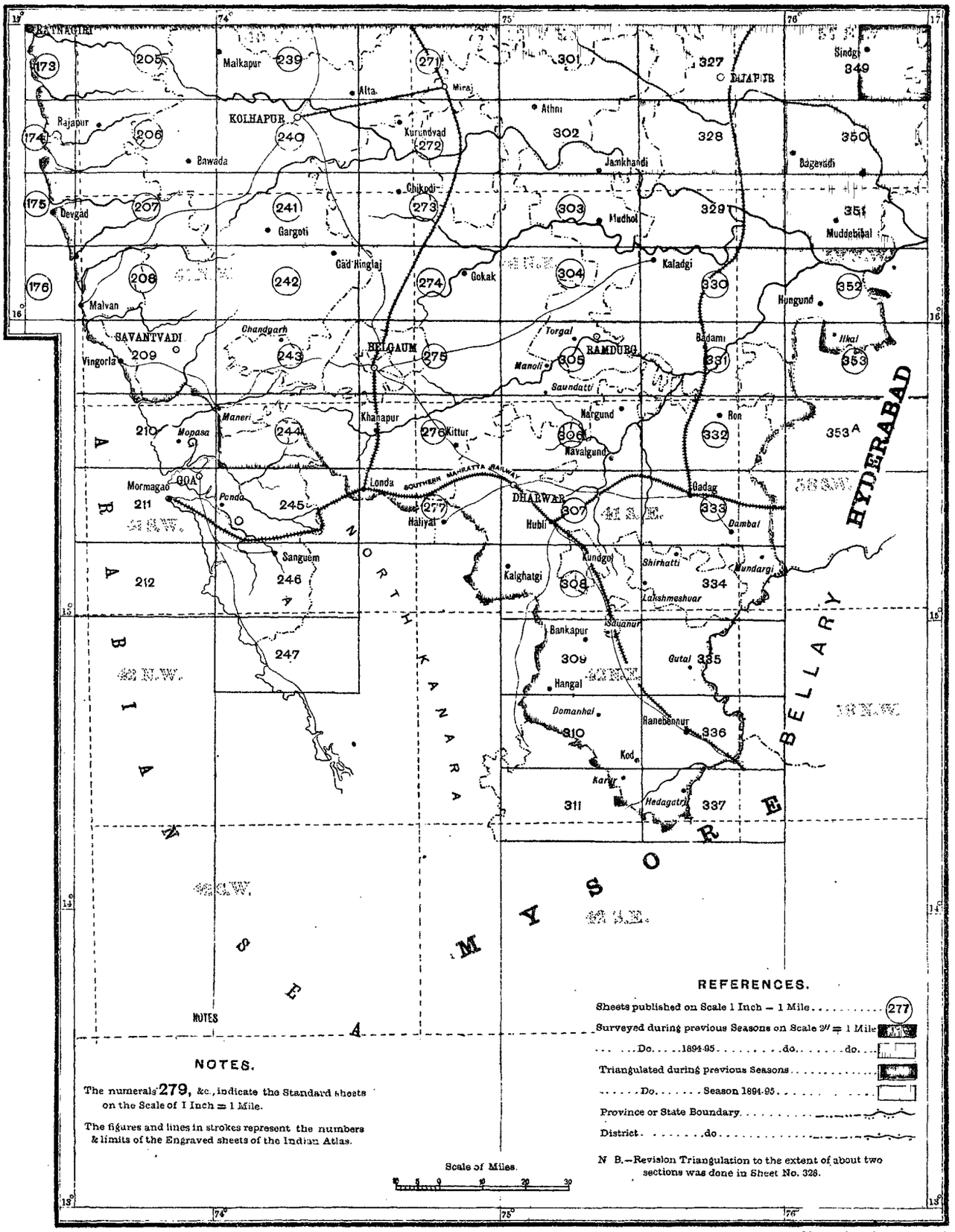
Triangulation	1,900 square miles.
Traversing	80 linear „
Topography, 2-inch scale	2,563 square „
Ditto. 8-inch „	15 „ „

* Lieutenant Burn speaks in high praise of the work done without exception by every member of the Party.

BOMBAY SURVEY.

INDEX TO THE BOMBAY TOPOGL. SURVEY IN SOUTHERN MARATHA COUNTRY.

1894-95. No. 10 PARTY.


RATNAGIRI
KOLHAPUR
SAVANTVADI
BELGAUM
RAMDURG
DHARWAR
BIJAPUR
HYDERABAD
BELLARY
NORTH KANARA
ARABIAN SEA
GOA
Malkapur
Alta.
Miraj
Athni
Rajapur
Kurundvad
Jamkhandi
Bagevadi
Bawada
Chikodi
Devgad
Gargoti
Mudhol
Muddebihal
Gad Hinglaj
Gokak
Kaladgi
Hungund
Malvan
Chandgarh
Torgal
Badami
Ilkal
Vingorla
Manoli
Saundatti
Maneri
Khanapur
Nargund
Ron
Mopasa
Kittur
Navalgund
Mormagao
Ponda
Londa
SOUTHERN MARATTA RAILWAY
Haliyal
Hubli
Gadag
Dambal
Sanguem
Kalghatgi
Kundgol
Shirhatti
Mundargi
Lakshmeshwar
Savanur
Bankapur
Gutal
Hangal
Domanhal
Ranebennur
Kod
Karur
Hedagatti
Sindgi
Sindgi
Muddebihal
Hungund
Ilkal
Badami
Gadag
Ron
Nargund
Navalgund
Dambal
Shirhatti
Mundargi
Lakshmeshwar
Savanur
Gutal
Ranebennur
Hedagatti
Kundgol
Kalghatgi
Bankapur
Hangal
Domanhal
Kod
Karur
Londa
Haliyal
Ponda
Sanguem
Mormagao
Vingorla
Devgad
Rajapur
Malvan
Bawada
Gad Hinglaj
Chandgarh
Maneri
Mopasa
Khanapur
Kittur
Torgal
Manoli
Saundatti
Chikodi
Gargoti
Kurundvad
Athni
Miraj
Alta.
Malkapur
Jamkhandi
Bagevadi
Muddebihal
Kaladgi
Gokak
Hungund
Ilkal
Badami

70. The detail survey was checked by 400 linear miles of test lines, and by *in situ* examinations. Clinometer heights were observed as last year with a view to greater accuracy of contouring, the intervals being 50 feet for the 2-inch and 25 feet for the 8-inch survey. The heights were checked on the 2-inch work by the assistant who ran the check lines, and on the 8-inch work by Lieutenant Fraser and Mr. Gibson.

71. The triangulation and traversing necessary for a 12-inch scale survey of Secunderabad cantonment was carried out, but nothing further was done pending the completion of the cadastral survey of Bolaram and Secunderabad on the 36-inch scale, which is now being undertaken by the Nizam's Survey Department. Should this survey be found on examination to be sufficiently accurate, a 12-inch plan of the cantonment will be made from it by reduction.

72. The country surveyed is undulating, dry, and for the most part devoid of trees and jungle except on the range of hills situated south of the river Krishna, which is covered with prickly pear and gave some trouble to the plane-tablers. During the early part of the season the *jowari* crops growing to a considerable height rendered the triangulation a difficult task to carry on

73. The health of the party has been on the whole good.

74. During the recess the computations of one sheet were completed and those of another partially so. The remaining computations will be completed during the ensuing field season. The mapping of the season's detail survey was completed without arrears.

75. The general reports of the Gujarat survey were proceeded with steadily during the year by Mr. Dickinson and a squad of sub-surveyors who did not take the field. It is estimated that they will be completed by March 1896.

76. The recess office of the party was inspected by the Surveyor-General at Poona in August 1895 and he found everything being carried on satisfactorily.

77. The programme for the ensuing season comprises the completion of the work in the Southern Maratha country, which is contained in sheets Nos. 328 and 350 and those parts of sheets Nos 349 and 351 which fall in British territory. The area remaining is 1,850 square miles In addition it is probable that a large scale survey of Hubli city will be undertaken and possibly one of the Secunderabad cantonment also. *

UPPER BURMA.

No. 11 PARTY.

78. The operations of this party have hitherto been classed under the head of geographical surveys, but as the most important part of its work during the year has been and in the future will continue to be regular 1 inch survey, it is now classed as a regular topographical party. As it was called upon to furnish the survey detachment for the Mekong Mission its strength was somewhat reduced, and its outturn was further affected by the fact that it commenced operations on the 1-inch scale for the first time and that there was very little triangulation done in advance.

Personnel.

Captain T. F. B. Renny-Tailyour, R.E., Deputy Superintendent, 2nd grade, in charge.
Mr. P. J. W. Doran, Extra Assistant Superintendent, 5th grade.
„ W. M. Kelly, Extra Assistant Superintendent, 6th grade.
„ H. G. Shaw, Sub-Assistant Superintendent, 2nd grade.

Surveyors and Sub-Surveyors.

Mahmud Hosein, J. Sebastian, Kudratullah, Mowni Ram, Nuruddin, Ram Pershad, and 4 apprentices.

79. The party left recess quarters at Bangalore at the end of October 1894 and proceeded to Taunggyi. Field operations were commenced during the last week of November. The programme for the season comprised the detail survey on the 1-inch scale of sheets Nos. 358 and 359, and on the $\frac{1}{4}$-inch scale of the north-east portion of the Keng Tung State, mostly falling in sheet No. 5 N.E., and of a small gap near the Salween river in the same sheet. There being an insufficiency of points for the 1-inch topographical surveyors, triangulation had to be pushed on at once in sheets No. 358, and 359 and the computa-

* Lieutenant Fraser reports favourably on the work of all his assistants.

tions worked out in the field. Triangulation was carried on in advance in sheets Nos. 360 and 361. The triangulation for the season's detail survey was entrusted to Messrs. Doran and Shaw, and on its completion they were employed in examining the work of the plane-tablers. Owing to the early setting in of the haze and the difficult nature of the country, Captain Renny-Tailyour found it necessary to undertake the advance triangulation himself, leaving the supervision of the detail survey to the above two Assistants. Mr. Kelly was at first employed in starting the detail surveyors at their work, who, being accustomed to work on the ¼-inch scale only, required a good deal of supervision at starting. He afterwards took up plane-tabling himself.

80. The outturn of work for the season is as follows :—

	Square miles.
Triangulation	1,910
Topography 1-inch scale	1,112
Ditto. ¼-inch „	2,156

81. The country surveyed on the 1-inch scale is mountainous, the ranges running more or less north and south, and being generally covered with jungle. The elevations varied from about 3,000 feet in the valleys to over 8,000 feet on the highest range, this range being one of the highest in the Shan States.

82. The area topographically surveyed on the 1-inch scale is but small, the party being much under the usual strength, both as regards European assistants and Native surveyors. Now that regular work has been allotted to it, it should be raised to the full strength of a topographical party to allow of its working economically and giving Government the full benefit of the money spent on it. With a view to carrying this out, steps are being taken to organize a training school for natives during the recess months at Bangalore, at which men will be taught plane-tabling and be drafted into this party as well as into Nos. 20 and 21, according to the requirements of each. As the vacancies in the Provincial service are filled up, it is hoped that suitable European assistants will also be available to make up the required number in these three parties, all of which are at present shorthanded.

83. The health of the party was good on the whole. There were several cases of fever on the road up to Taunggyi, and also at the end of the field season, the rains in the Shan States commencing about the beginning of April.

84. The establishment had returned to Fort Stedman by the first week in May 1895, and proceeded to recess quarters at Bangalore, where the office opened on the 1st June. During the recess the party had to draw the fair maps and compute the triangulation for the Mekong Mission, and owing to the urgency and importance of this work the fair mapping of the season's 1-inch surveys was delayed. Only sheet No. 358 was completed, and the hill drawing on sheet No. 359 will have to be completed in the Calcutta Drawing Office. On the ¼-inch scale, besides the Mekong Mission maps, sheet No. 5 N. E., was drawn, and an addition made to sheet No. 5 S.E.

85. The recess office of the party was inspected at Bangalore by the Surveyor-General in September, who was well satisfied with the general efficiency of the party and the work executed by it during the past year, both in the field and in recess.

86. The programme for the ensuing season comprises the detail survey on the 1-inch scale of sheets Nos. 360 and 361, and the completion of sheet No. 315. Triangulation will be completed in sheets Nos 360 and 361 and carried on in advance in sheets Nos. 316, 317, 362, and 363.*

* Captain Renny-Tailyour reports that Mr. Doran has shown himself most zealous in the discharge of his duties and his experience was of the greatest assistance. Mr. Kelly showed great energy and his knowledge of 1-inch work was found most useful. Mr. Shaw also performed his duties in a very satisfactory manner and proved himself a very accurate triangulator.

Of the native establishment surveyors Mahmud Hosein, Sebastian, Kudratullah, Nuruddin, and Ram Pershad are well reported on.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA & SHAN STATES.

1894-95. Nos. 11 & 21 PARTIES.

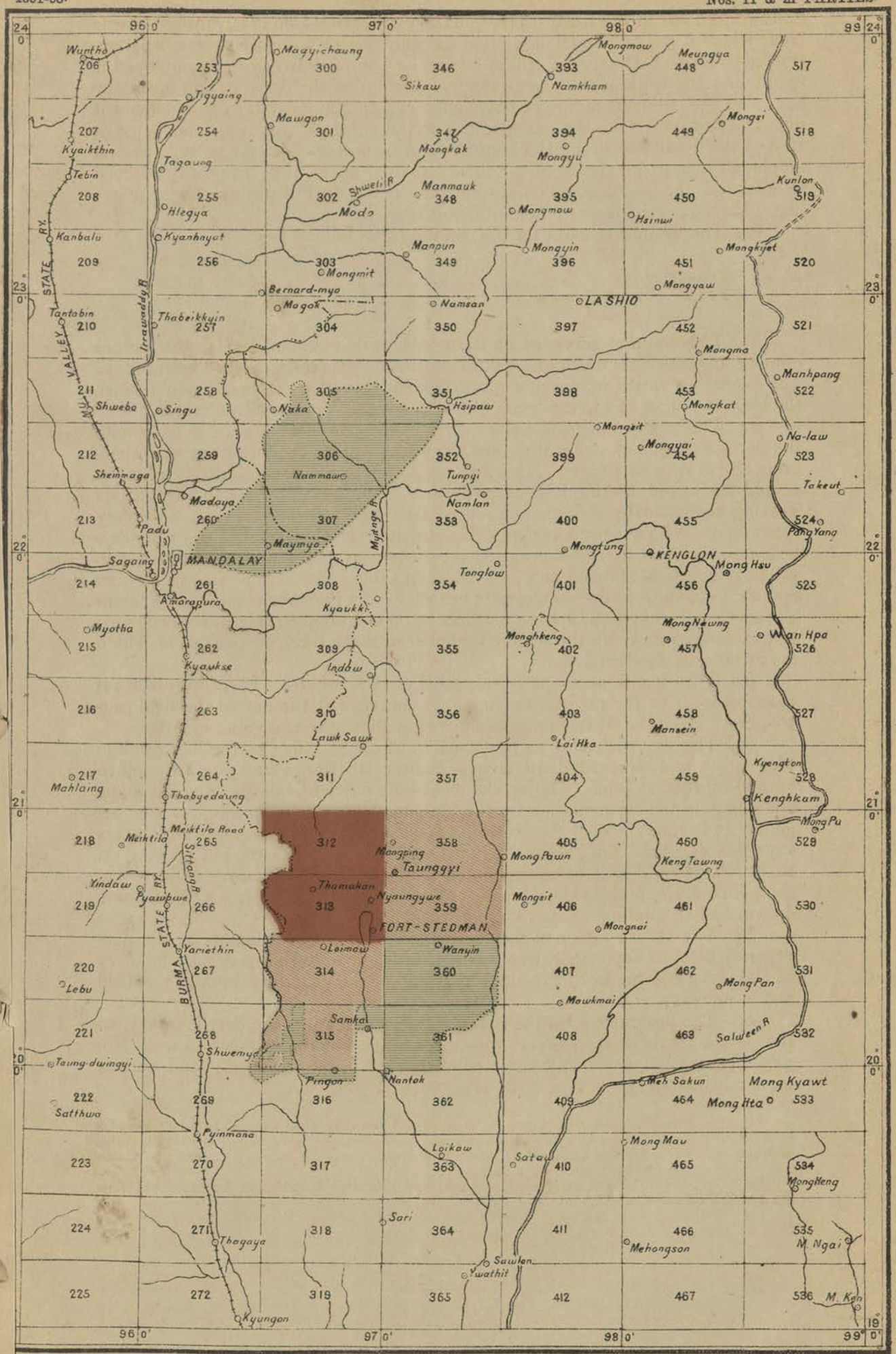


Photo., S. I. O., Calcutta.

No. 308-S. 96.

NOTE.

The numerals 312, &c., indicate the Standard sheets on the Scale of 1 Inch = 4 Miles.

REFERENCES.

Area previously Surveyed

Surveyed in Season 1894-95

Triangulated in advance

Scale of Miles.

Miles 32 16 0 32 Miles

BALUCHISTAN.

No. 15 Party.

87. This party remained under the charge of Colonel Holdich until June 14th, when he proceeded to join the Pamir Delimitation Commission and the charge devolved upon Mr. T. E. M. Claudius for the remainder of the year.

Personnel.

Colonel T. H. Holdich, C.B., C.I.E., R.E., Superintendent, 1st grade, in charge up to 14th June 1895.
Captain R. J. H. L. Mackenzie, R.E., Deputy Superintendent, 2nd grade, up to 30th June 1895.
Lieutenant W. M. Coldstream, R.E., Assistant Superintendent, 2nd grade.
Mr. T. E. M. Claudius, Extra Assistant Superintendent, 4th grade, in charge from 14th June 1895.
„ E. A. Wainwright, Extra Assistant Superintendent, 5th grade.
„ G. P. Tate, Sub-Assistant Superintendent, 1st grade, up to 29th June 1895.
Yusaf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 2nd grade.
Hira Singh, Rai Bahadur, Sub-Assistant Superintendent, 2nd grade.
Imam Sharif, Khan Bahadur, Sub-Assistant Superintendent, 3rd grade.
Mr. P. Williams, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Ahmed Ali Khan Bahadur, Abdul Guffar Khan Saheb, Sheik Mohiuddin Khan Bahadur, Asghar Ali, Gopal Singh, Jaffer Ali, Mohamed Naki, Madat Khan, Nizamuddin, and thirteen others.

88. The party was divided into nine detachments, of which the first three were detailed for service with the Afghan Boundary Commission, *viz.*, the Asmar Section, the Baluch-Afghan Section, and the Kurram Section, under Colonel Holdich, Captain Mackenzie, and Lieutenant Macaulay, respectively. The fourth detachment, under Mr. Claudius, continued the 6-inch scale survey of Multan city and environs. The fifth, under Mr. Wainwright, carried on surveys on the $\frac{1}{2}$-inch scale in the Upper Zhob district. The remaining four detachments consisted of Sub-Assistant Superintendents Yusaf Sharif and Imam Sharif, Surveyor Sheik Mohiuddin and Sub-Surveyor Ahmed Hussein, each of whom was detailed for special duty in South Persia, Arabia, the Perso-Baluch frontier, and the Las Beyla district respectively.

89. The operations on which the party were engaged were:—

(1) Triangulation for $\frac{1}{2}$-inch scale surveys and $\frac{1}{4}$-inch and $\frac{1}{8}$-inch reconnaissances.
(2) Topography including—
  (*a*) Military survey of Multan city and environs on the 6-inch scale.
  (*b*) Surveys in connection with the Indo and Baluch-Afghan Boundary Commissions on the 2-inch, 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch scales.
  (*c*) Surveys on the $\frac{1}{2}$-inch scale in the Las Beyla and Upper Zhob districts.
  (*d*) Reconnaissances on the $\frac{1}{8}$-inch scale on the Perso-Baluch frontier and in Persia and Arabia.

90. The Asmar Section of the Afghan Boundary Commission, under Colonel Holdich, accompanied by Lieutenant Coldstream and three surveyors, left Peshawar on the 1st December 1894, and returned about the middle of April 1895, after mapping about 1,200 square miles of country in the Kunar and Asmar valleys on the $\frac{1}{2}$-inch scale.

The Baluch-Afghan Section under Captain Mackenzie, with five surveyors, continued its work throughout the winter. The outturn of work comprised 80 square miles surveyed on the 2-inch scale, 3,603 square miles on the $\frac{1}{2}$-inch scale, and 1,570 square miles on the $\frac{1}{4}$-inch scale. The delimitation work was suspended about the end of May 1895 and will be resumed during October. Captain Mackenzie unfortunately fell seriously ill after his return to Quetta and was obliged to take furlough in July.

The Kurram Section, under Lieutenant Macaulay, completed its work by the end of December 1894, having added 360 square miles, surveyed on the 1-inch scale, to its previous outturn. An area of 30 square miles was also surveyed on the $\frac{1}{2}$-inch scale. Before the completion of these operations Lieutenant Macaulay was ordered to join the Waziristan Delimitation Commission, under Major Wahab, R.E., and was unfortunately killed in the fight which occurred at Wano on the 3rd November 1894.

91. The detachment under Mr. Claudius (with the head-quarters of the party) took the field in the neighbourhood of Multan early in November, and completed the traversing and topography of an area of 95 square miles, on the 6-inch scale, for military purposes. On the completion of this work early in March, Mr. Claudius with the head-quarters' office returned to Quetta, leaving Mr. P. Williams to carry on traverses in connection with the 2-inch survey along the left bank of the Chenab, also required by the Military Department.

92. The Upper Zhob detachment, under Mr. Wainwright, completed the triangulation for ½-inch topography of 4,500 square miles. The survey on the same scale of sheet No. 115 was completed, and that of sheet No. 123 would also have been finished but for the withdrawal of Surveyor Asghar Ali, transferred to the survey detachment with the Chitral Relief Force. The total area surveyed on the ½-inch scale by this detachment amounted to 2,715 square miles.

93. Khan Bahadur Yusaf Sharif, with Surveyor Jamaluddin, mapped about 19,000 square miles on the ⅛-inch scale of new country between Bandar Abbas and Jask, in South Persia. Jamaluddin also surveyed the summit of the Ginao range on the 1-inch scale, or an area of 60 square miles. The plateau stands about 6,000 feet above sea level, and would answer admirably for a sanitarium. Yusaf Sharif was also successful in connecting the different triangulations which he had executed during previous seasons at Charbar, Jask, and Bandar Abbas, and the whole of his work, which forms a continuous series from Charbar to Jask, has been recomputed f om the values of the latitude, longitude, and azimuth supplied by No. 22 Party at Charbar and Jask.

94. Khan Bahadur Imam Sharif again accompanied Mr. Theodore Bent on a tour of exploration in the Hadramaut country, South Arabia. A good deal of their programme had to be abandoned, owing to the hostility of the natives. The Khan Bahadur managed, however, to map about 3,000 square miles on the ⅛-inch scale in the Dofar district, which is creditable considering the difficulties and dangers the party had to encounter and overcome.

95. Khan Bahadur Sheik Mohiuddin again distinguished himself in the field of exploration, having mapped about 40,000 square miles of country on the ⅛-inch scale in Western Baluchistan and Persia, and revised about 5,000 square miles of hitherto roughly surveyed ground in the neighbourhood of Kharan. His report on this work has been separately printed. The Government of India has been pleased to bestow upon him the title of Khan Bahadur in recognition of his services.

96. Sub-Surveyor Ahmed Hussein was deputed to fill in all the gaps which existed in sheet No. 97, on the ½-inch scale in the Las Beyla district, which work he accomplished very successfully with an outturn of 900 square miles. The Mengals who were so troublesome during the previous season were unusually quiet, which enabled him to complete his work without interruption.

97. The total outturn of the party is as follows :—

	Square miles.
Triangulation, for ½-inch survey	4,500
Ditto ⅛-inch reconnaissance	24,000
TOTAL	28,500

	Linear miles.
Traversing, for 16-inch survey	317
Ditto 6-inch do	258
Ditto 2-inch do	226
TOTAL	801

	Square miles.
Topographical survey, 6-inch scale	95
Ditto 2-inch do	80
Ditto 1-inch do	420
Ditto ½-inch do	8,418
Geographical ditto ¼-inch do	1,570
Ditto ⅛-inch do	67,000
TOTAL	77,583

98. The programme for the ensuing field season will comprise the following operations:—Surveys on the 2-inch scale for military purposes of a certain area along the left bank of the Chenab river. The completion of all $\frac{1}{2}$-inch surveys in the Las Beyla and Wad districts, as also in Lower Zhob, the Musakhel country, and the Kaisor Valley. The survey of the Bhittani country will also be undertaken. It is also proposed that this party shall execute the 1-inch survey of the hills between the Great Kirthar range and the plains, which form the eastern portion of Sind. The triangulation will be carried on this season, whilst No. 12 Party, which has been transferred to that province, will commence the 2 inch topographical survey of the cultivated country near Karachi. One sub-surveyor will be deputed to join Lieutenant Sykes at Kirman. Mr. G. P. Tate will replace Captain Mackenzie with the Baluch-Afghan Boundary Commissions.

99. The recess office of the party was inspected by the Surveyor-General at Quetta in September 1895, when the triangulation of Baluchistan generally was carefully examined. It sorely needs a more reliable foundation, and that the detached portions be tied together on a firm basis. A first class series will this year be commenced, which will eventually be carried through Mekran into Persia, thus furnishing correct bases for all southern Baluchistan. The office generally was in excellent order, thanks to the good arrangements of Mr. Claudius, who has virtually had the executive charge of the party during the absence of Colonel Holdich with the Asmar detachment, and has actually had sole charge whilst that officer has been on deputation with the Pamir Commission.*

HIMALAYAS, PUNJAB.

No. 18 Party.

100. Owing to the absence of Major R.A. Wahab, R. E., on deputation with the Waziristan Delimitation Commission, and there being no officer of the Imperial Service available, the charge of the party devolved on Mr. C. D. Potter, Extra Assistant Superintendent, till he handed over charge to Lieutenant C. L. Robertson, R.E., on 2nd July 1895.

Personnel:

Lieutenant C. L. Robertson, R.E., Assistant Superintendent, 1st grade, in charge from 2nd July 1895.
Mr. C. D. Potter, Extra Assistant Superintendent, 4th grade, in charge up to 1st July 1895.
„ W. Robert, Extra Assistant Superintendent, 5th grade.
„ W. A. Fielding, Extra Assistant Superintendent, 6th grade.
„ R. Waller, Senior-Sub-Assistant Superintendent, 1st grade.
„ W. M. Gorman, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Shah Nasiruddin, Atma Singh, Wahid Ali Khan, Ram Saran, Asmatullah Khan, Dalbir Rai, Amir Singh and 27 others.

101. The work on which the party was engaged during the year was in continuation of that of the previous season.

102. The operations of the season comprised—

(i) Topographical survey on the 4-inch scale in Kangra district and its sub-division of Kulu, showing the boundaries of all Government forests as demarcated or pointed out by the Revenue or Forest authorities, in addition to all topographical details;

(ii) Topographical survey on the 2-inch scale of the Native states of Mandi and Suket;

(iii) Special survey on the 4-inch scale of the forest areas in the Native states of Patiala, Sirmur and Kalsia;

(iv) Revision of the Simla Municipal boundaries and of the survey of the roads and buildings within municipal limits on the 24-inch scale, by surveyors deputed under the Deputy Commissioner of Simla for the purpose;

(v) Triangulation in advance of topography for work on the 4-inch and 2-inch scales in the Simla hill states and Kulu, and in the Native states of Mandi and Suket respectively.

* Mr. Claudius reports that all the members of the party, both European and Native, with one exception, have worked with energy and good-will.

103. In the Kangra district and in the Simla hill states a classification of forest timber and soils was carried out at the same time as the topography.

104. As in previous years, the party was broken up into several detachments for the field season, each working independently under the immediate charge of an assistant. This arrangement has been found the most suitable for ensuring the necessary supervision over the sub-surveyors in the field working in such a country as the Himalayas, where the areas under survey each season are at considerable distances from each other. Under this system each assistant has practically independent charge of his detachment, and is visited once or if possible more often during the field season by the officer in charge of the party.

105. The detachments left Simla for the field at various dates according as their work lay in higher or lower ground. That under Mr. Robert, working in Upper Kulu on the 4-inch scale, was the first to go out and left recess quarters in the middle of August, so as to take full advantage of the few fine autumn months in which alone work in the high ground there can be satisfactorily carried on. This detachment moved down to Mandi on completion of the work in Kulu in the beginning of December and continued work there on the 2-inch scale during the winter and early spring months.

106. The Kangra detachment, under Mr. Fielding, took the field during the second week in October and remained employed on 4-inch topography in the Kangra district till the end of April 1895.

The third detachment under Mr. Potter commenced work in Sirmur and Kalsia hill states during the latter part of October; and in the early spring the survey of the forests in Patiala State, previously commenced, was again taken up and carried on till the end of June 1895 by which time all those members of the detachment who had not already finished the work allotted to them and gone on leave, had returned to recess.

107. The outturn of triangulation for the year amounts to 340 square miles, and the existing triangulation was strengthened over an additional area of 240 square miles previously reported. The triangulation was carried out by Mr. Waller-Senior and Sub-Surveyor Wahid Ali Khan, working independently of the detachments.

108. The areas topographically surveyed are 478 and 406 square miles on the 4-inch and 2-inch scales respectively, as compared with 540 and 305 square miles respectively during the previous season. The decrease in the outturn of 4-inch work was due to more time being devoted to the 2-inch work than during the previous season.

109. The areas topographically surveyed in the various localities are as follows:—

Locality.	Scale.	Area in square miles.
Kangra	4 inches = 1 mile .	196·0
Kulu	Ditto .	156·3
Sirmur	Ditto .	80·8
Patiala	Ditto .	22·2
Kalsia	Ditto .	22·5
Mandi and Suket	2 inches = 1 mile .	405·5
	Total .	883·3

The total outturn is in excess of that of the previous year by 38·75 square miles.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

1894-95. No. 18 PARTY.

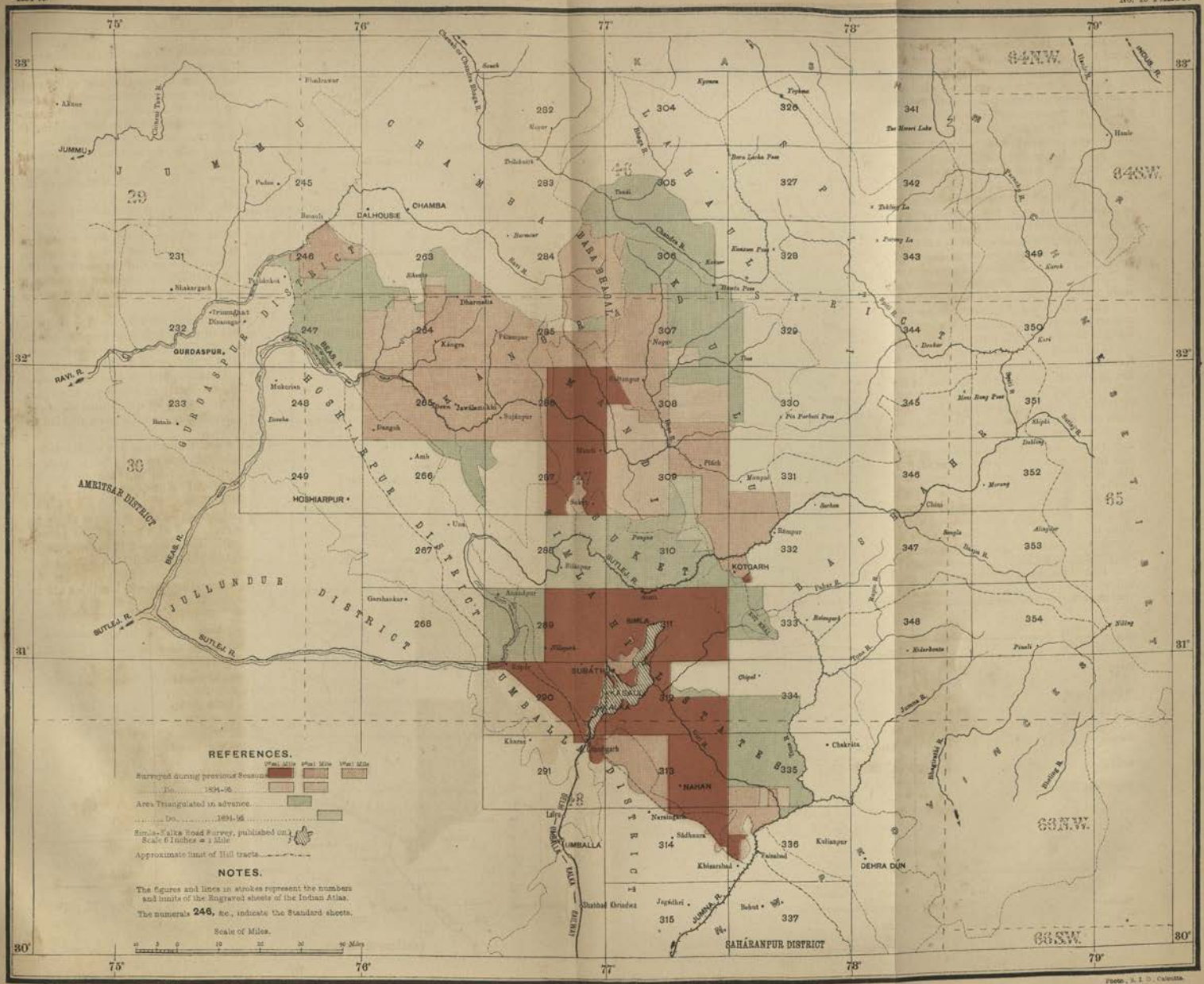


Photo., S. I. D., Calcutta.

No. 309-S. 96.

110. In the areas surveyed on the 4-inch scale certain forest blocks were included, the details of which are shown below :—

Locality.	Number of blocks.	Class.	Area in square miles.
Kangra	6	Reserved .	3·7
Nurpur	29	Protected .	22·9
Kulu	61	Reserved, 1st and 2nd class.	118·3
Sirmur	77	Reserved .	61·5
Kalsia	13	Ditto .	14·5
Patiala	55	1st and 2nd class	8·3
TOTAL .	241	.....	229·2

111. The cost-rates per square mile of the different classes of work are as follows :—

	₹
Triangulation	14·3
Detail survey, 2-inch scale	36·5
Detail survey, 4-inch scale (not forest lands)	87·7
Special forest surveys, 4-inch scale	67·9

The aggregate cost-rate of operations on the 4-inch scale, including cost-rate of triangulation for the previous season, *i.e.*, ₹9·7 per square mile, is ₹87·5 per square mile.

Considering the difficulties which have to be overcome when surveying in the Himalayas, which were mentioned in paragraph 99 of last year's report, the cost-rate of ₹77·6 per square mile (including triangulation) will compare favourably with that of other similar surveys.

112. Two soldier surveyors were under instruction during the season as heretofore. One of these has completed his course during the year and returned to his regiment, his place being taken by a new man from the 2-2nd Gurkha Rifles, who will commence the usual course of training next field season.

113. The recess office of the party was inspected by the Surveyor-General in June 1895, and on the 1st July and following days the Superintendent of Trigonometrical Surveys made his annual inspection of the party. He was well satisfied with the progress that had been made both with the field work and the fair mapping, as also with the general arrangements for dealing with the large amount of work that has to be got through in a limited recess season, and, with a view to facilitating the bringing up of the arrears of fair mapping, he made certain proposals for equalising the lengths of the field and recess seasons, which it is intended to put into execution during the ensuing year.

114. The programme for next field season provides for the continuation of the past season's operations, and includes triangulation in Kulu for work on the 4-inch scale; 4-inch topography in Northern Kulu and in the Kangra district; topography on the 2-inch scale in the Native states of Mandi and Suket; and the special forest surveys asked for by the Patiala and Sirmur States, the surveys of the forests of the former of which should be completed this season.*

* Lieutenant Robertson reports most favourably on the work done by Messrs. Potter, Robert, Fielding Waller-Senior and Gorman. Mr. Potter was also in temporary charge of the party for the whole of the field season in addition to his other duties; and Lieutenant Robertson reports that he has been of the greatest assistance to him in the executive work of the party. Of the native establishment, Surveyor Shah Nasiruddin and Sub-Surveyors Fateh Mahomed, Ram Singh, Munshi Ram and the Clerk, Amir Singh, are commended.

UPPER BURMA.

No. 21 Party.

115. The party remained under the charge of Major Longe until the 8th July 1895, on which date he proceeded to England on privilege leave for two months and twenty-two days, and the charge devolved upon Mr. A. J. Wilson. Before the expiration of his leave, Major Longe was placed on special duty at the India Office in connection with the Burma-China frontier negotiations.

Personnel.

Major F. B. Longe, R.E., Deputy Superintendent, 1st grade, in charge up to 7th July 1895.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, in charge from 8th July 1895.
„ A. J. James, Extra Assistant Superintendent, 4th grade.
„ W. F. E. Adams, Sub-Assistant Superintendent, 2nd grade.

Surveyors and sub-surveyors.

Ikbaluddin, Lachman Jadow, Mohammad Latif, Mohammad Alam, Natha Singh, Budhi Balram, and two apprentices.

116. The party left recess quarters in Bangalore early in November 1894 and proceeded to the various localities in which operations were to be carried on about the 20th November and returned to recess quarters about the 20th May 1895.

117. The operations of the season comprised —

(1) The continuation of the 1-inch topographical survey of the Southern Shan States.
(2) The completion of the geographical survey on the $\frac{1}{4}$-inch scale of the Northern Shan States and the Upper Chindwin district.
(3) The demarcation of the Amherst-Siam boundary.
(4) The geographical survey on the $\frac{1}{4}$-inch scale of the Kokang State.

118. Mr. A. J. Wilson, with Mr. Adams and three sub-surveyors, undertook the continuation of the 1-inch work in the Southern Shan States, and arrived at Kalaw on the 27th November. After starting the men at work, Mr. Wilson took up the triangulation in advance of about 200 square miles, visiting the plane-tablers at intervals during the course of his work, and surveying the boundaries in each section as it was completed, thereby effecting a thorough check on each surveyor's work. The plane-tabling was carried on without hindrance until the end of April, when the rains set in and the men began to fall sick. The topography fell within the limits of sheets Nos. 314 and 315 and it was hoped that both would have been completed, but this was found impossible and about one-third of sheet No. 315 had to be left over. The work was closed on the 2nd May, after completing 913 square miles of topography on the 1-inch scale. In addition to this, Mr. Wilson completed 200 square miles of advance triangulation and 91 linear miles of boundary survey.

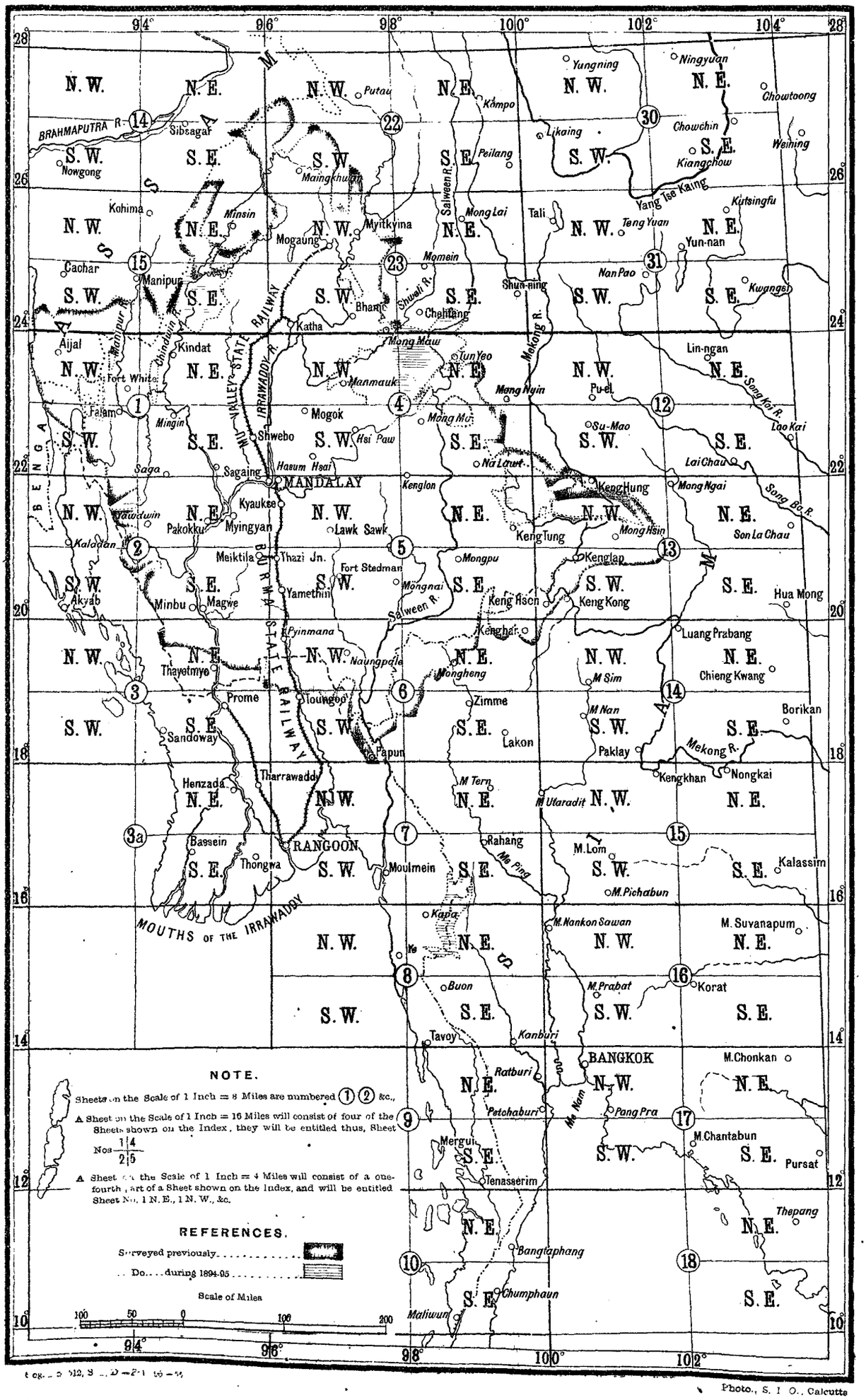
119. The 1-inch survey was carried on in eight states, of which five are completed. A list of the states and areas is given below :—

States.	Areas.	Remarks.
Nankè	90·72	Incomplete.
Lwelon	315·16	Do.
Lwè-e	153·75	Completed.
Lwè Mow	47·80	Do.
Yaung Hwe	100·70	Do.
Saga	36·26	Incomplete.
Thamakan	55·10	Completed.
Thigyit	38·50	Do.

120. Mr. A. J. James was detailed to carry on the advance triangulation for next season's detail survey on the 1-inch scale in the Northern Shan States. He commenced work on the 27th November and completed 1,500 square miles by the end of February 1895. He observed at seventeen stations and fixed 169 intersected points. Of the area triangulated, 1,000 square miles is in advance for next season's work, the remainder having been done for the use of the Quarter-master-General's Department in the Mandalay district. On the 1st March

INDEX TO THE GEOGRAPHICAL SURVEY IN BURMA.

1894-95. Nos. 11 & 21 PARTIES.



NOTE.

Sheets on the Scale of 1 Inch = 8 Miles are numbered (1) (2) &c.,

A Sheet on the Scale of 1 Inch = 16 Miles will consist of four of the Sheets shown on the Index, they will be entitled thus, Sheet Nos 1|4 / 2|5

A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of a Sheet shown on the Index, and will be entitled Sheet No. 1 N.E., 1 N.W., &c.

REFERENCES.

Surveyed previously.....

Do....during 1894-95.....

Scale of Miles

100 50 0 100 200

Photo., S. I. O., Calcutta

No. 333-S. 96.

Mr. James was ordered to close the triangulation and proceed to Lashio to take up some detail survey on the ¼-inch scale in North Hsinwi.

121. The demarcation of the Burma-Siam boundary was entrusted to Surveyor Ikbaluddin. He proceeded to Moulmein on the 27th November and there received written instructions from the Deputy Commissioner of Amherst. After carrying on some triangulation the surveyor reached Krontaw police outpost on the 19th December, and halted there to await the arrival of the officer in charge of the demarcation party on the 21st. On the following day the party left for Three Pagodas, where they met the Siamese Commissioners. The surveyor here commenced a plane-table and traverse survey in accordance with his instructions, and continued work until the 4th June when he had completed the detail survey on the ¼-inch scale of 1,726 square miles, the triangulation of about 2,000 square miles and a route traverse on the 1-inch scale of 500 linear miles. The demarcation was left incomplete owing to the heavy rain which set in about the middle of May, but will be completed next season. When unable to continue operations on the boundary, the party returned by a new route through Siamese territory, which was traversed and mapped by the surveyor. He remained at Moulmein from the 4th to the 17th June in order to complete his tracings and compute the latitudes, longitudes, and heights of the stations for the Deputy Commissioner. The surveyor has received the thanks of the Chief Commissioner of Burma for his services while employed on this duty.

122. In February 1895 it was decided that Major Longe, accompanied by the Superintendent, Northern Shan States, and one sub-surveyor, should visit and survey the Kokang State, which was to be ceded to China under the Anglo-Chinese Convention, while Mr. James, on the completion of his triangulation, was deputed to complete the survey of North Hsinwi with Surveyor Lachman Jadow. This work was satisfactorily accomplished, Major Longe himself surveyed an area of 1,475 square miles, and Sub-surveyor Natha Singh an area of 1,587 square miles, in the Kokang State, while Mr. James and Lachman Jadow between them obtained 3,107 square miles in North Hsinwi, all on the ¼-inch scale. Before his return Major Longe prepared a complete topographical report on the boundary laid down in article 3 of the Convention, together with a sketch of the ground, for the information of the Chief Commissioner of Burma.

123. The aggregate outturn of the party for the season is as follows:—

	Square miles.
Triangulation	3,700
Topographical survey, 1-inch scale . . .	913
Geographical survey, ¼-inch scale . . .	10,247

124. A good deal of sickness was experienced towards the end of the field season, chiefly malarial fever of a severe type, from which one sub-surveyor died on return to recess quarters and one *khalási* on the voyage back to Madras.

125. During the recess all the computations have been completed and fresh editions of the following maps were prepared, *viz.*: sheets Nos. 4 North-East and North-West, 15 South-East, and 23 South-East. Sheet No. 314 on the 1-inch scale will shortly be completed, and all the above sheets will be sent in for reproduction by the commencement of next field season.

126. The Surveyor-General inspected the recess office of the party at Bangalore in August 1895.

127. The programme for the ensuing season is as follows:—Major Longe, with one surveyor, will continue the triangulation and geographical survey north of Bhamo. Mr. Wilson, with the bulk of the party, will be employed first on triangulation and will then commence the 1-inch survey of the ground triangulated in advance in Hsi Paw of the Northern Shan States. Surveyor Ikbaluddin will again accompany the Amherst-Siam Boundary Commission. Sub-surveyor Mohammad Latif will continue the revision survey in sheet No. 15 South-East, and Surveyor Lachman Jadow will accompany Mr. Duff to explore the country along the frontier north of Taping. Should Captain Eliott, Superintendent of the Northern Shan States, go to the Trans-Salween Shan States, one surveyor must also be sent to accompany him. The 1-inch triangulation will be continued by Lieutenant Robertson, who

is under transfer to the party from No. 18 Party, and by Mr. James until the hazy weather sets in, when they can be otherwise employed.*

INDUS RIVER, SIND.

DETACHMENT.

128. The survey of the Indus river was continued by this detachment in fulfilment of the programme laid down in paragraph 121 of last year's General Report. Mr. Keelan retained the charge until his death, which occurred on the 26th January at Jerruck, near Tatta, when Mr. G. P. Tate was placed in charge.

Personnel.
Mr. H. E. Keelan, Extra Assistant Superintendent, 1st grade, in charge up to 26th January 1895.
Mr. G. P. Tate, Sub-Asssitant Superintendent, 1st grade, in charge from 2nd February 1895.
Nine sub-surveyors.

129. The detachment took the field on the 1st November 1894. The headquarters remained at Kotri until the 11th January 1895, when the office was transferred to Tatta.

130. The *modus operandi* was similar to that described in previous reports. Main traverses were run and connected with trigonometrically fixed points, and they embraced a strip of country about a mile and a half wide on either bank of the river, which was surveyed in detail on the 1-inch scale, in addition to the actual course of the river.

131. During the season 527 linear miles of main circuits and 846 linear miles of minor circuits were run, the whole embracing an area of 828 square miles. To check the angular work azimuths were observed at 59 stations.

The following table gives the particulars of the detail survey executed:—

District.	Number of villages.	Number of plane table fixings.	Linear miles of chaining.	Area in square miles.
Hyderabad	15	450	97·4	54·80
Karachi	169	7,962	1,275·6	943·47
TOTALS .	184	8,412	1,373	998·27

132. The detail survey was checked by 67 linear miles of test lines run by the officer in charge. A small portion of the work near the coast was also checked by *in situ* examination and by plane-table traverses.

133. In addition to the computation of main traverses and the plotting of field sections, duplicate plots of each field section were prepared in the office of the detachment and submitted to the Commissioner in Sind. A copy of the numerical data of all the traverses was also made for that officer from the final computations.

134. During recess the computations and fair drawing of the standard sheets were completed. The latter were ten in number, and special copies of them were made for the use of the Irrigation Department for the recording of the annual changes in the course of the river. Traces of certain field sections in the delta were supplied in advance to the Commissioner. A rough chart was also compiled showing the triangulation existing and available for use in Lower Sind to assist in laying out the work for next field season.

135. The survey for which the detachment was constituted has now been brought to a close. The establishment will next season be amalgamated with that of No. 12 Party, which, on completion of its work in Burma, is to undertake the re-survey of the Sind province.†

* Mr. Wilson reports that Mr. A. J. James is deserving of special commendation for the successful manner in which he carried on the triangulation. Mr. Adams also gave satisfaction.
Of the surveyors, Ikbaluddin and Lachman Jadow, and of the sub-surveyors, Mohammad Latif, Mohammad Alam, Natha Singh, and Jamna Persad, are selected for special mention.

† Mr. Tate reports that the surveyors have on the whole worked very satisfactorily both in the field and in recess.

SIND SURVEY.

1894-95. INDEX TO THE INDUS RIVERAIN SURVEY. DETACHMENT.

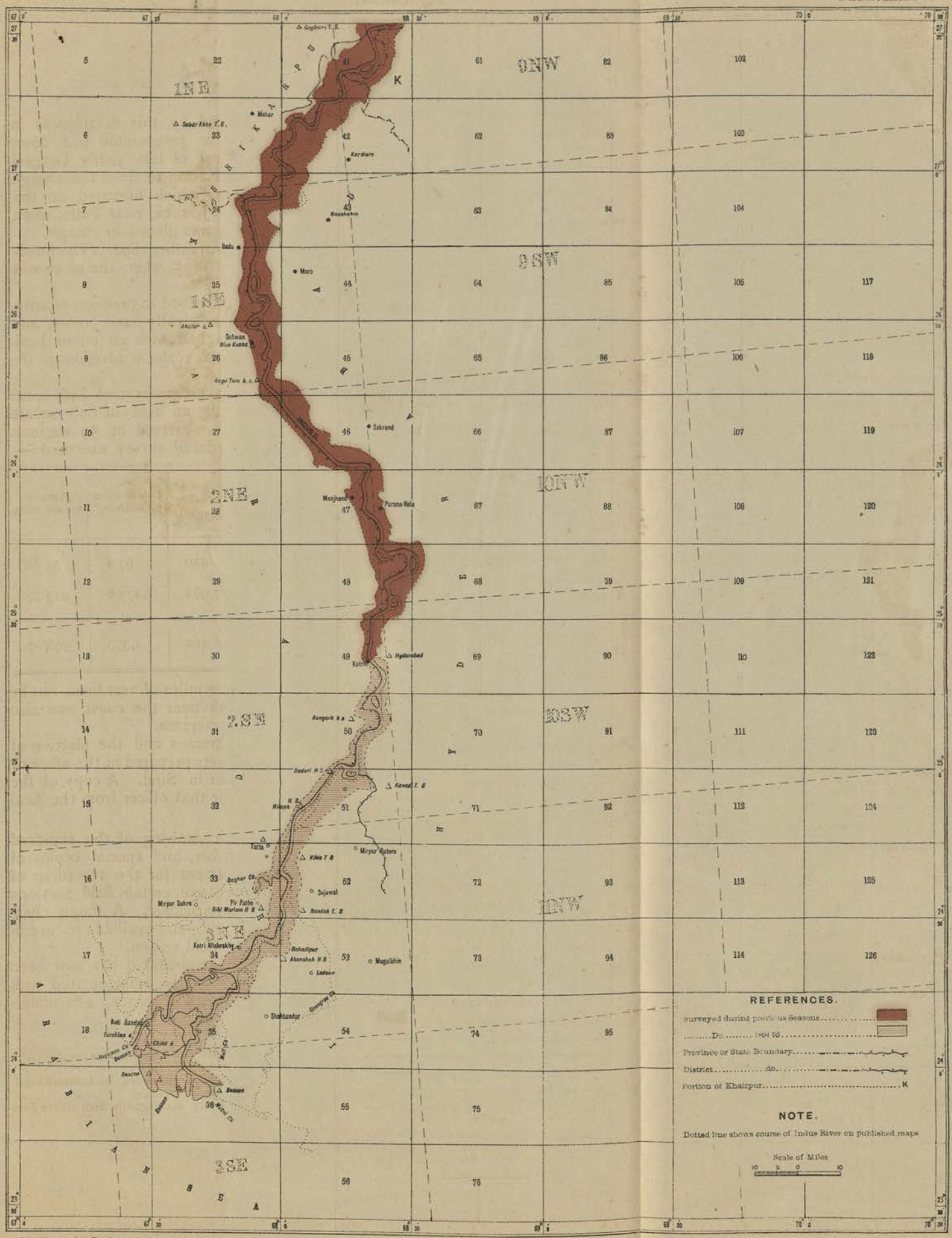


Photo. S. I. O., Calcutta

No. 315-S. 96.

ORISSA.

DETACHMENT.

136. This detachment continued under the supervision of Mr. R. C. D. Ewing throughout the year. The field operations comprised the completion of the cadastral survey of a few scattered *mahals* in districts Cuttack and Balasore, and of the topographical survey on the 2-inch scale of the permanently settled estates in districts Puri, Cuttack and Balasore.

Personnel.

Mr. R. C. D. Ewing, Extra Assistant Superintendent, 5th grade, in charge.
„ E. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
Babu Nilmony Chatterjee, Sub-Assistant Superintendent, 2nd grade.
8 sub-surveyors.
3 computers and draftsmen.

Temporary Establishment.

8 sub-surveyors.
5 inspectors.
5 *amins*.
15 field surveyors.

137. The area remaining to complete the cadastral survey of the Cuttack and Balasore districts amounted to only $5\frac{1}{2}$ square miles. The particulars thereof are shown in the following statement —

District.	Cadastral Survey. 16 inches=1 Mile.		
	No. of villages.	No. of fields.	Area in square miles.
Cuttack	43	8,988	5·0
Balasore	2	662	0·5
Totals	45	9,650	5·5

138. In connection with the Cuttack survey much miscellaneous work was also done in office. The accessory work of 4,156 *mauzas* was completed and examined during the season, which entirely cleared off all arrears. Of the above *mauzas* the tracings of 563 (having 807,620 numbers) were prepared, examined and sent to the Settlement Officer, and the areas in duplicate were extracted of 57 *mauzas*, having 56,397 plots.

Tracings of 97 villages, having 57,681 plots, of tracts under irrigation in Cuttack and Balasore, were supplied to the Superintending Engineer, Orissa Circle, at cost rates, in accordance with indents received from time to time.

A tracing of the Cuttack cantonment boundary was prepared at the request of the Collector for the use of the Station Staff Officer.

139. Of district Balasore, the accessory work of 464 *mauzas* was completed.

Of the 552 village boundary disputes of the previous season, submitted to the Settlement Officer of Balasore for settlement, the decisions of 312 have been received, and 140 still remain unsettled and the sheet maps uncorrected. There are also several remaining undecided of previous seasons.

One set of tracings of Balasore town, on the 32-inch scale, in 7 sections, was prepared and submitted to the Bengal Government. Another set was traced for the Balasore Municipality, for whom also two charts, one showing the directions of the several lines of levels run through the town, and the other the vertical sections, have been prepared.

140. The chief work of the season consisted in the topographical survey on the 2-inch scale, with boundaries of villages, of all the permanently settled portions of the Orissa division, which was notified in the *Calcutta Gazette* of the 3rd December 1894.

141. The tracts for survey are either single *parganas* or groups of *parganas*, some of which are situated on the extreme south of the division on the borders of Madras, while others are at the northernmost point touching the district of Midnapore, in Bengal.

The survey was completed during the season, and the blanks shown in last year's index maps have thus been filled up. The operations in each of the districts will be described separately.

Survey of the Puri District.

142. The area surveyed in detail on the 2-inch scale was 473·12 square miles, excluding 13 square miles of overlap. The number of villages was 15·5. The area surveyed includes 310 square miles of the Chilka lake and 10 islands.

143. The detail was surveyed in 17 sections, and tested by check lines passing through each of the sections, and aggregating in all 17 miles; the work stood the test very well.

The island of Nalbano on the Chilka is submerged during the greater part of the year, its shape and size being indicated by the reeds growing on it; the other islands in the lake are of rocky formation and uncultivable.

In connecting the 10 islands which lie in the Chilka, 162 stations were observed at with 52⅝ miles of chaining.

144. The traversing has cost ₹3,962, and the topographical survey ₹1,406; the rates are, for traversing ₹32·2, and for topographical survey ₹8 per square mile.

Survey of the Cuttack District.

145. In the Cuttack district the area surveyed in detail on the 2-inch scale amounted to 660·65 square miles.

146. The detail survey is contained in 45 sections, over which 97½ linear miles of check surveys were run; the hills were, moreover, tested *in situ*. The heights of hills were ascertained by the clinometer, and the position of streams through heavy jungle by cutting lines through jungle and off-setting to the principal bends.

147. A large portion of Aul *pargana* is so low as to remain submerged during the rainy season, but during November, December and January *dalua* cultivation is carried on, *i.e.*, as the water recedes, portions are terraced off, and in this liquid mud paddy is sown, which matures within three months.

Bishanpur is an open well-cultivated *pargana*, but of Harispur the greater portion, more particularly towards the sea-coast, consists of jungle, water, and sand.

148. The Great Trigonometrical pillar station of Dasomat was connected with; but the adjacent ones could not be found, being probably covered over by sand.

149. The Dompara Raja rendered very willing assistance, and his people helped the party to the best of their ability. As the *pargana*, for the most part, consists of hills covered with jungle, any opposition would have caused much trouble and delay.

The Kalkala Raja was very attentive, and his people were always ready to render any assistance required, which in a great measure helped the rapid completion of the work. The eastern boundary, touching *killa* Darpan, being under dispute, the claims of both parties were surveyed, and on to the map was transferred the boundary surveyed topographically in 1838—42. The area in dispute is 1,318 acres covered with hills and jungle, hence it is not an easy matter to ascertain which party is in possession, but the boundary, according to previous survey, coincided, for the most part, with the claim of Kalkala. The map of this dispute has been submitted to the Settlement Officer of Cuttack for settlement.

150. The Sukinda estate has boundary disputes with all its neighbours: the dispute with *killa* Madhupur was not of much consequence, and was settled and demarcated during this field season. The dispute with *killa* Dhenkanal was surveyed last season at the Raja's request and on the promise to pay all expenses. At the north-west corner of the estate, exterior of the boundary, are a few scattered temporary huts of migratory cowherds and iron-smelters, which the Raja claimed as part of his estate. This claim covers approximately more than 30 square miles and is well within Dhenkanal, which, becoming apparent on transferring the boundary from the previous topographical survey map of 1837—42, the traverse and survey of the tract had necessarily to be discontinued, much to the annoyance and disappointment of the Raja who gave much trouble and delayed the survey.

151. Of Darpan 57 square miles of irrigated tracts of the High Level Canal had been previously traversed and cadastrally surveyed; the remainder,

having an area of 71 square miles, came within the present season's work and comprises as much cultivated area as it does waste lands covered with hills and jungle. The *zamindar*, Raja Boidyanath Pandit, rendered most opportune assistance with coolies and supplies.

152. The cost of the traverse survey has been ₹13,953, and of the topographical survey ₹219; the resulting rates are ₹21·6 for traverse, and ₹9·4 for topographical survey per square mile.

Survey of the Balasore District.

153. In district Balasore the topographical survey of 189·65 square miles was completed on the 2-inch scale.

154. The detail survey was completed in 18 sections and tested by 43 miles of chaining, which proved the accuracy of the work.

155. The boundary between Moharbhanj State and *parganas* Bhelora chour and Jellasore, according to the present survey, is very different from that shown in the map of 1838. It appears that Moharbhanj has been steadily encroaching on the Balasore villages, several of which have been entirely absorbed and others partially so. A map has been prepared and copy submitted to the Settlement Officer of Balasore, showing the lines of boundary according to the survey of 1838, and by the Midnapore survey of 1874—77 and of the present season according to possession. The area between the line of boundary of 1838 and that now pointed out is 7·41 square miles.

156. The cost of the traverse survey has been ₹3,823, and of the topographical survey ₹1,767; the resulting cost-rates are ₹20·1 for the traverse and ₹9·3 for the topographical survey per square mile.

157. The total area traversed in the three districts has been 958 square miles, and the area topographically surveyed has been 1,012 square miles, which is exclusive of 310 square miles of the Chilka Lake. An overlap of 13 square miles was also surveyed in order that the lake might be fully mapped, for the south-west extremity of the lake is in the Madras Presidency, and also in order that the line of the East Coast Railway, constructed from Madras to Cuttack, skirting the western shore, might be shown in the new publication of the standard sheets of Orissa.

The graticules for the field sheets were projected in sizes $7\frac{1}{2}$ feet $\times 3\frac{3}{4}$ feet or $3\frac{3}{4}$ feet $\times 3\frac{3}{4}$ feet when found more suitable. All the sections were filled in with detail survey before the close of the season.

Intermediate heights were obtained by means of the clinometer from heights fixed by the Great Trigonometrical survey of hills and bench marks; each line of contour represents an interval of 50 feet.

The boundaries of 1,258 villages were mapped on the 2-inch scale in the course of the operations.

158. During the season under report five training schools were opened under Mr. Ewing's supervision with a view to the training of the *sarbarakhars* of the Khurda Government estate, in district Puri Of 795 *sarbarakhars* who went through the course, 697 passed as qualified, and arrangements were made for the remainder to qualify before the commencement of the next field season.

The course of instruction comprised, (1) field surveying (on plane-table and by field book), (2) rules for the writing of record of-rights, and (3) extraction of areas and the mapping of fields. A grant of ₹4,600 was made for the training of *sarbarakhars*, of which ₹3,302 were expended. It is expected that a further sum of ₹1,000 will be expended before all the men have qualified.

159. Mr. Ewing's services have now been placed at the disposal of the Bengal Government, and the revision survey of the maps of 1875-77 of the Khurda Government estates will be carried out under the order of the Settlement Department.*

* Mr. Ewing reports that Mr. E. F. Berkeley has worked well, and that Babu Nilmony Chatterjee took great interest in the training schools for *sarbarakhars*. He has improved in departmental knowledge and works with earnestness

Of the Native establishment, Jagabandhu Kanungo and Jowala Pershad are said to have worked excellently.

WAZIRISTAN.

DETACHMENT.

160. The survey detachment detailed to accompany the Waziristan section of the Afghan Boundary Commission under Major Wahab arrived at Dehra Ismail Khan on the 1st October 1894, and marched on the 4th for Kajuri Kach, reaching that place on the 10th.

Personnel.

Major R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge.
Lieutenant P. J. F. Macaulay, R.E., Assistant Superintendent, 2nd grade, up to 3rd November 1894.
Lieutenant C. L. Robertson, R.E., Assistant Superintendent, 2nd grade.
Hussain Buksh, Surveyor.
Jaffer Ali, do.
Naik Sher Jung, Soldier Surveyor.

161. Survey operations were at once commenced, the surveyors being sent out reconnoitring to Spin and Kutina, and the Toi valley, whereby a considerable area of previously unmapped country was surveyed.

162. On the 22nd October the party marched with the Delimitation Escort under Brigadier-General Turner, and reached Wana on the 25th. The whole party was present during the attack on the escort camp on the 3rd November, and Lieutenant Macaulay was unfortunately killed while making his way to the scene of the fighting. While the force remained at Wana, survey work was carried on in the neighbourhood, and a fairly complete map of Wana and Spin was prepared and published on the $\frac{1}{4}$-inch scale, embodying the results of the survey up to the latest date.

163. On the 18th December Major Wahab and Lieutenant Robertson with two native surveyors (one had been invalided and sent back to Kajuri Kach) left Wana with the 1st Brigade, Waziristan Field Force, for Kaniguram, and while there much new work was done in the direction of Pirghal, all the valleys to the south and south-east of which were thoroughly reconnoitred. Major Wahab and one surveyor then moved to Makin, and on the 31st December joined the 3rd Brigade under Colonel Egerton, and accompanied him on his march through the Shaktu and Suzha valleys, rejoining the head-quarters of the force at Jandola on the 8th January. Lieutenant Robertson had in the meantime been employed in surveying the Shinkai and Splitoi valleys visited by the 1st Brigade, and on the return of that brigade to Wana by the Gomal route, he accompanied a column which explored the route leading from Nilai Kach by the Khuzhma pass to the head of the Danaoti valley, rejoining the main body at Karabkot, and was successful in mapping a large area of previously unsurveyed country to the south and south-east of Kundighar.

164. From Jandola Major Wahab marched with the 2nd Brigade to Kundiwam, revising the map of the Shapur valley, and re-surveying where necessary. Surveyor Hussain Baksh was again attached to Colonel Egerton's column, and did some excellent work in surveying the country between Jandola and the hills west of Bannu.

165. On the 22nd January Major Wahab left Kundiwam for Wana to join the Boundary Commission under Mr. L. W. King, C.S., Domandi, on the Gomal, was reached on the 28th, and the survey and demarcation of the boundary from that point to Khwaja Khidr, at the head of the Birmal and Shawal valleys, occupied the party until the 13th February; the last five or six days' work were done under great difficulties, owing to the short time available and the inclement weather. On the 14th this party returned to Wana, and on the 16th, after finishing up the map of the boundary, left for Bannu to join the force advancing up the Tochi.

166. Lieutenant Robertson and Sher Jung were employed during the month in surveying the Khaisara and Shakai valleys, and the hills between the Shakai and Wana; they accompanied the column which attempted to explore the Dahna valley, but owing to the severity of the weather it was impossible to reach the head of that valley, and some of the high hills between the Dahna and Shawal were thus unavoidably unsurveyed; he then proceeded to Bannu, where the whole party was again assembled on the 22nd February.

167. On the 24th the head-quarters of the force moved to Mirzail, entering the Tochi on the 25th. Here the resources of the party were taxed to the utmost, as there had been no opportunity for preliminary reconnaissance and

triangulation, and this and the necessary computations had to be done as the force advanced. Rai Bahadur Hira Singh, Sub-Assistant Superintendent, who had joined the party at Bannu, was detached at Idak, and succeeded in mapping as much of the country as could be reached from that post, his work including practically all Lower Dawar. At Sheranni, which was reached on the 2nd March, the party was again divided, Major Wahab and Surveyor Hussain Baksh as before accompanying the demarcation party, now under Mr. H. A. Anderson, C.S., and Lieutenant Robertson remaining at Sheranni with the head-quarters of the force. Sher Jung was sent to Muhammed Khel, on the formation of a post there.

168. On the 5th the demarcation from Charkhel southwards was commenced; here again wet and cloudy weather greatly impeded survey work, and, owing to the shortness of the time allowed for this part of the work, it was impossible to reach Khwaja Khidr and thus complete the survey of the high ground which, as mentioned above, Lieutenant Robertson had been unable to reach from the Dahna valley. This section was completed on the 22nd March, and the party rejoined the brigade at Datta Khel, where orders were received for the demarcation of the boundary between Charkhel and Laram. This was commenced on the 26th, and completed on the 5th April, when the party rejoined the force at Darpa Khel.

169. The area surveyed lies between 32°·0′ and 33°15′ N.lat., and 69°·15′ and 70°·15′ E. long., and includes the strip of country between the Gomal river on the south and the range of hills bordering the Tochi valley on the north, extending for roughly sixty miles beyond the Punjab frontier. The total area surveyed on the $\frac{1}{2}$-inch scale is 3,680 square miles, of which about 2,000 represents new survey, besides a large area hitherto imperfectly surveyed. Some small gaps still remain in the Mahsud country, and at the head of the Dahna, which the surveyors had no opportunity of visiting, but with these exceptions the whole area traversed by the force has been surveyed as completely as circumstances permitted.*

FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 Party.

170. The party remained under the charge of Captain W. J. Bythell, R.E., until 27th March 1895, when he was deputed as Survey Officer with the Chitral Relief Force and his place was temporarily filled by the senior assistant, Mr. N. C. Gwynne, there being no officer of the Imperial list available. Captain Bythell returned from the expedition and resumed charge of the party on 20th September 1895.

Personnel.

Captain W. J. Bythell, R.E., Deputy Superintendent, 2nd grade, in charge up to 27th March and from 20th September 1895.
Mr. N. C. Gwynne, Extra Assistant Superintendent, 3rd grade, in charge from 27th March to 19th September 1895.
„ J. Keating, Extra Assistant Superintendent, 6th grade.
„ D. Campbell, Sub-Assistant Superintendent, 1st grade, up to 25th January 1895.
Munshi Rahmatullah, Sub-Assistant Superintendent, 3rd grade.
Mr. J. O. Greiff, ditto ditto.

Surveyors and Sub-Surveyors.

Muhammad Zakaria, Gurdutt Singh, Karimdad Khan, Ram Singh, Niaz Husain, and fifty others.

171. The party assembled at Harda, district Hoshangabad, on 1st December 1894, and from thence the several sections marched to their field of operations in districts Nimar, Betul, and Damoh respectively. Field work was continued till the end of April, and with the exception of one triangulator and some traversers who, to complete certain portions of work, were left out working till the first week of June, the field establishment was broken up by the 12th of May 1895.

* Major Wahab reports that Surveyor Hussain Baksh did excellent work as a plane-tabler, and his skill and rapidity as a draftsman were of the greatest value. He worked incessantly, without a day's rest, since the advance from Wana, and his services deserve special recognition. Naik Sher Jung, attached to the party as a soldier-surveyor, has also worked most creditably and deserves advancement.

172. The party carried out survey work in the Government forests of districts Nimar and Betul in continuation of the previous year's operations, and commenced the survey of forests in district Damoh.

173. Triangulation was carried out in district Betul in sheets Nos. 19, 25, 26, 35, 36, and 37, and in district Damoh in sheets Nos. 61, 62, 63, 64, 82, 83, and 84. The total area triangulated in district Betul amounted to 785 square miles. Out of this amount, 150 square miles has also been surveyed in detail in the season under report, and the balance remains in advance for next year, containing about 386 square miles of actual forest area. The area of triangulation done in district Damoh is 1,378 square miles. This, however, embraces only about 428 square miles of ground for actual topography, as the forests in that district are broken up into small isolated blocks separated and encircled by *malguzari* land.

174. Traversing of forest boundaries and fire lines was mostly done in advance of topography. In a few instances it was also carried out over the ground which came under detail survey operations during the season, to supplement the work where left out in the previous year. The total outturn of traversing is as follows:—

	Linear miles.
District Nimar	20·0
„ Betul	689·8
„ Damoh	542·6

In addition to regular traverse work, measurements of offsets to boundary pillars over 222 linear miles of forest boundaries in districts Hoshangabad and Betul were taken during the season. These boundaries were surveyed during seasons 1889 to 1891, but offsets to boundary pillars were not taken at the time. It now became necessary to have these measurements made, in order to supply the forest officers with data of all the forest boundary pillars.

175. The total area of topography completed during the season amounts to 569 square miles. This embraces 217·6 square miles of "A" class forests in district Nimar, completing the extent of Government forests in that district set apart for survey in its entirety, and the balance of 351·4 square miles consists of "B" class forests in district Betul. All the plane-table sections were tested in the field by check lines or *in situ* fixings, by the officer in charge and the assistants of the party, and the work stood the test very well. The aggregate length of the check lines run through the work is 274·8 linear miles.

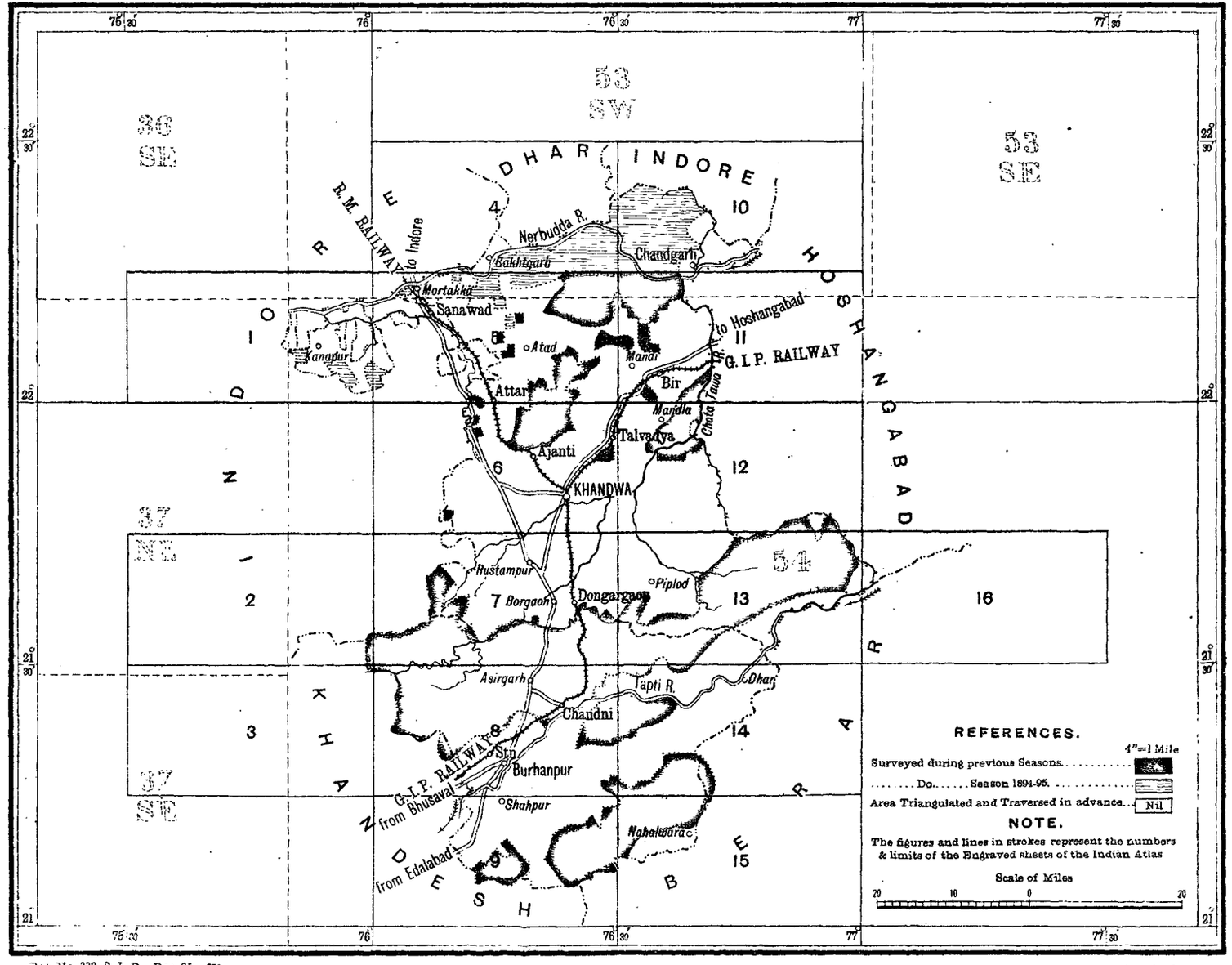
176. The classification of forest growth and soil of all the area surveyed in detail was carried out in the field on separate skeleton traces by the surveyors; the fair maps thereof have been prepared in the recess and supplied, in original, to the forest officers concerned.

177. The ground surveyed in detail in district Nimar consisted of the Chandgarh reserve, a portion of the Punasa reserve south of the Nerbudda, and other small reserves contiguous to it, with a few small outlying pieces of forest in the extreme north-west corner of the district. The ground in Punasa and Chandgarh reserves, along the sides of the Nerbudda, was about the most difficult for survey, being cut up by numerous deep ravines and thickly clad with teak and miscellaneous forest, with an intermixture of bamboos. The remaining portion of the ground was generally covered with *salai* forest and long grass. Water, except in the tracts bordering on the Nerbudda, was scarce, especially in the north of Chandgarh where most of the temporary streams dried up after the middle of February. Provisions had to be imported, as usual, as the greater portion of the area surveyed was quite uninhabited; labour was also difficult to obtain. The famous temples of Ornkar Mandhata are within a mile or two of the season's work. A complete and interesting description of these temples is given in the *Gazetteer* of the Central Provinces. The Nerbudda is the only river which drains a portion of the season's work in district Nimar. There are two ferries at Sakarghat and Bhitkhera, which, however, are only passable for foot passengers, and camels had to go round *viâ* Nowghata or Barkesar, some four and eight miles, respectively, east of the limits of the work. At Sakarghat, and for about a mile on either side of the ferry, the whole volume of the river pours through a narrow gorge of great depth and of an average width of some sixty yards, though in places narrowing to twenty. The rocks here are of a peculiar black colour, and this,

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DIST. NIMAR.

1894-95. No. 14 PARTY.



Reg No. 333. S. I. D.—Dec 95.—550.

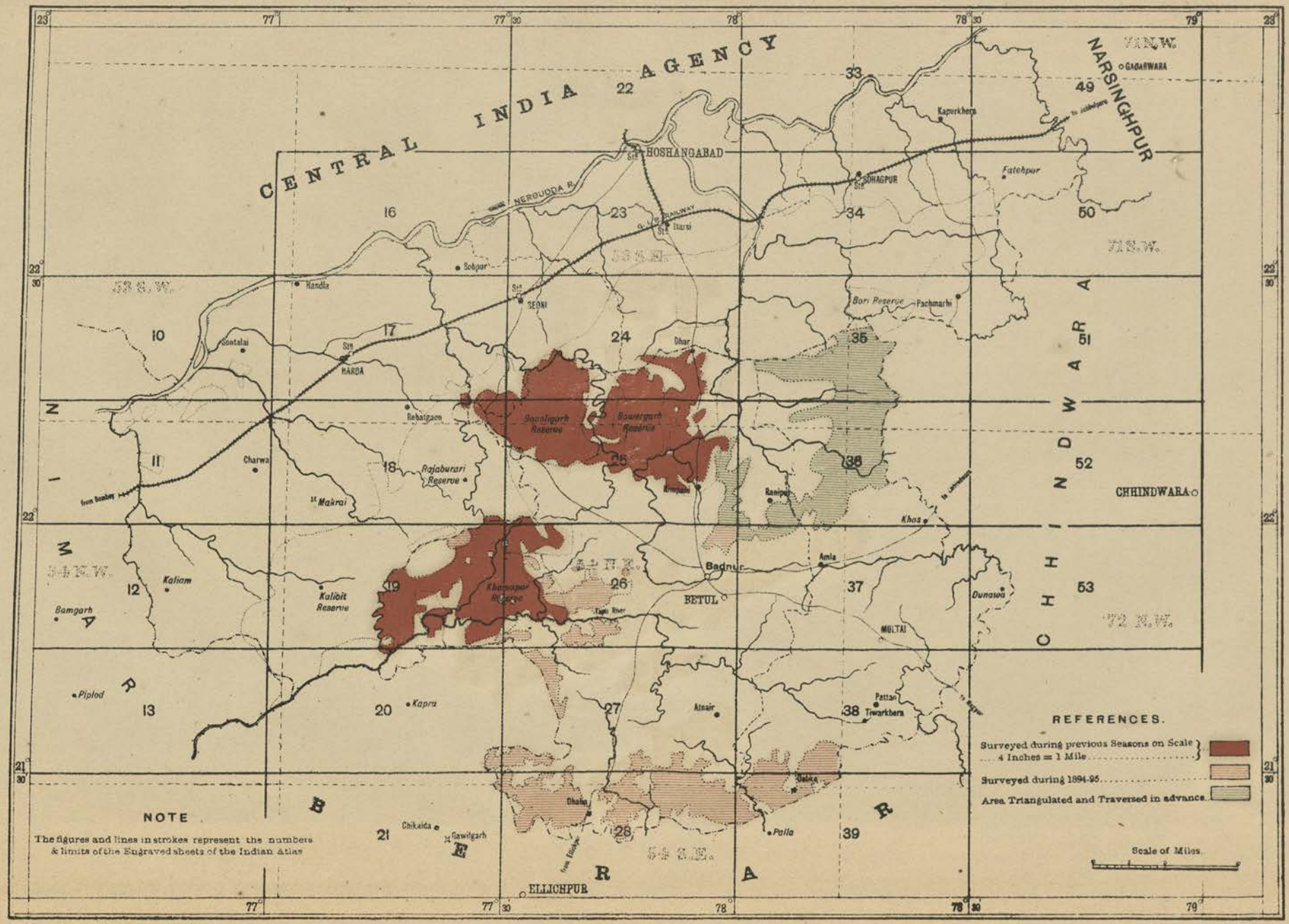
Photo., S. I. O., Calcutta.

No. 551-S. 95.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DIST. BETUL.

1894-95. No. 14 PARTY.



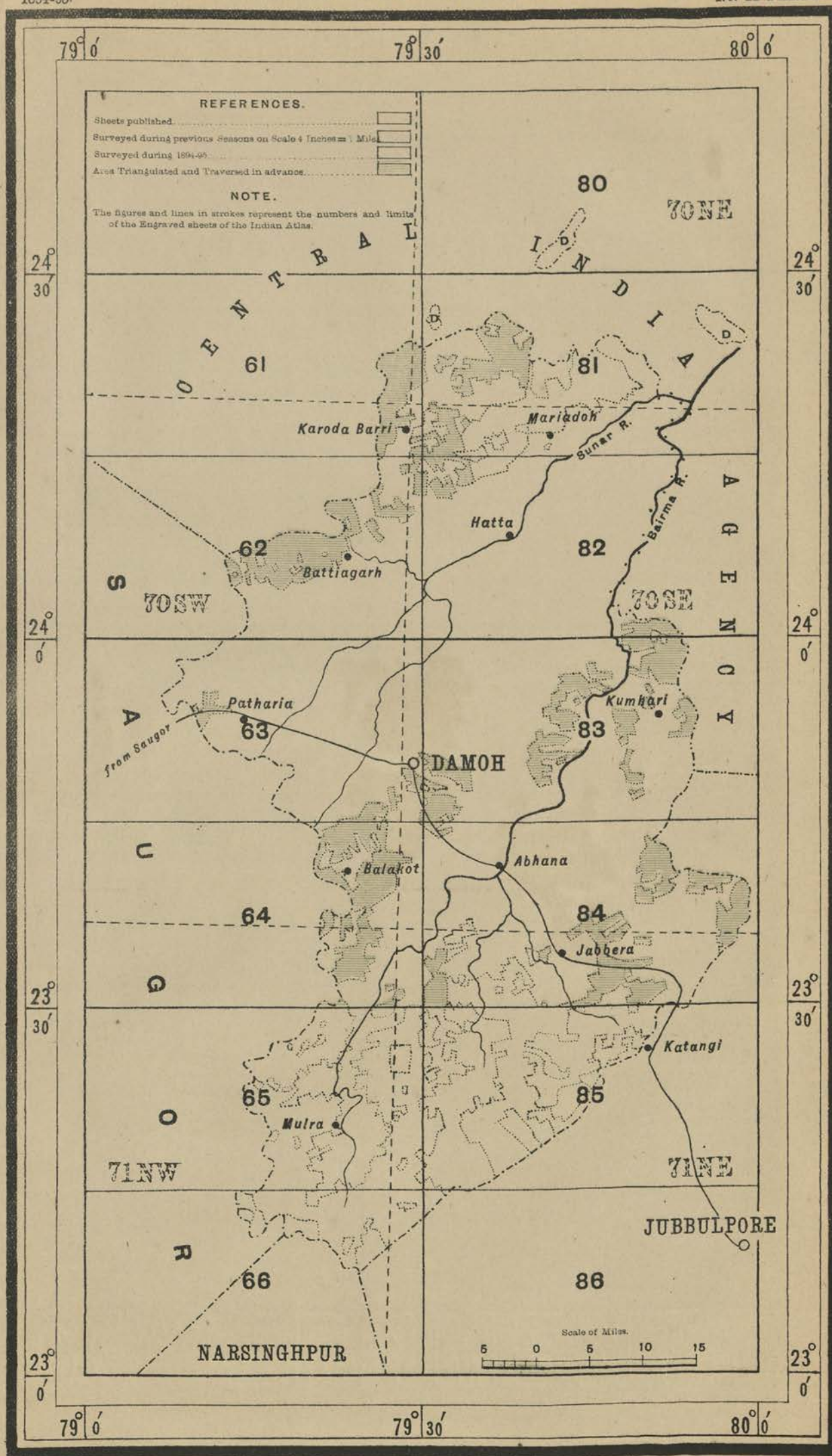
Reg. No. 333, S. I. D.—Dec 95.—550.

Photo S. I. O. Calcutta.

No. 552-S. 95.

CENTRAL PROVINCES SURVEY.

1894-95. INDEX TO THE FOREST SURVEY IN DISTRICT DAMOH. No. 14 PARTY.



Reg. No. 418. S. I. D.—Jan. 96.—550.

Photo., S. I. O., Calcutta.

No. 307-S. 96.

with the swift, silent passage of the deep river gives this portion of its course a grim and weird aspect.

The ground surveyed in district Betul consists of the "B" class forests in sheets Nos. 19, 20, 26, 27, 28, 38, and 39. The ground south of the Tapti river is composed, in places, of high and precipitous hills, here and there covered with heavy forest and long grass, but in others, of rolling hills, sparsely clad with trees of uniform height and size, while that north of the Tapti is overgrown with solid bamboos and miscellaneous forest. With the exception of the country in the vicinity of Dhár, south of Bhaisdehi, where the plateau of Betul drops some 1,500 feet sheer towards the plains of Berar, the general aspect of the jungle may be said to be tame and uninteresting. The country is exceptionally unhealthy and malarious, and the water-supply is very bad. The standing pools in the river beds, which form the only source of water in many cases, are generally covered with a greasy, slimy film, probably the result of rotting leaves, etc., and most of the fever may be traced to the drinking of this water. With the exception of the temples at Muktaghiri (Shekhdala) in sheet No. 28, there is nothing of archæological interest in the season's work in this district. The Tapti is the only river of importance which may be mentioned in connection with the season's work. It does not pass through or touch the work anywhere, but has to be constantly crossed in going from one portion of the work to another. It is fordable almost everywhere.

178. The health of the party in the season under report differed with the *locale* of operations in the three districts. The squads working in district Nimar generally remained in a fair condition of health throughout the season. The Betul section of the party suffered most severely from fever and dysentery. There were also some cases of pneumonia during December and January, and Mr. Campbell succumbed to this disease on the 25th January 1895. There was scarcely any member of the party in district Betul who did not suffer more or less from fever, and some of the sub-surveyors were quite disabled through sickness from doing any field work for periods varying from a week to a month. In district Damoh the establishment suffered from fever and dysentery during December and January. But towards the end of March several cases of guinea-worm occurred, causing great pain and trouble to the patients and incapacitating them for any work for the remainder of the season.

179. The fair mapping of the season's topography, consisting of fifty-six standard-sized sections sheets of Nos. 1, 4, 5, and 10 in district Nimar, and 19, 20, 21, 26, 27, 28, 38, and 39 in district Betul, will be completed before the party goes down to the field. This amount of mapping considerably exceeds anything which has been done by this party in one recess season since its formation. In addition to the above, index maps to the forest surveys in districts Bilaspur and Sambalpur have been prepared in the office of the party. The large amount of mapping to be completed has kept all hands fully employed during the recess, and for this reason it has not been found possible to continue the preparation of the traverse data mentioned in paragraph 134 of last year's report. But this will be taken in hand during the field season.

All the computations of the triangulation and traversing done during the field season are now nearly completed, and there will be no arrears by the end of this recess season.

180. The cost-rates of the different operations are as follows :—

Detail survey,	₹ 67·4	per square mile, against		₹ 89·0	last year.
Traversing,	₹ 11·7	„	„	₹ 17·8	„
Triangulation,	₹ 8·9	„	„	₹ 17·7	„

The decrease in the cost-rate of detail survey is principally due to Captain Bythell having been deputed to accompany the Chitral Field Force, and to the death during the field season of Mr. Campbell, Sub-Assistant Superintendent, and one native surveyor. The cost of triangulation is also considerably lower, more native surveyors having been employed on this duty.

These cost-rates are exceptionally low, and it is probable that next year the cost-rates will approach the figures for season 1893-94.

181. Four military students were attached to the party at the commencement of the year. Three of them, who belonged to the Corps of Guides, were recalled to their regiments under orders for the Chitral Relief Force at the end of March 1895 before they had fully completed their course of survey training.

The fourth man remained with the party throughout the year, and has been employed on independent detail survey work on the 4-inch scale, which he performed accurately and well. He will be instructed in the use of the theodolite, sextant and artificial horizon for time and latitude observations in the coming field season.

182. The programme for the ensuing field season is as follows :—

(*a*) Triangulation in the forests remaining to be surveyed in district Damoh, and commencement of triangulation in the forests of district Bilaspur.

(*b*) Theodolite traversing of all the forest boundaries, fire lines, etc., over the ground to be triangulated.

(*c*) Detail survey on 4-inch scale of all the forests remaining to be surveyed in district Betul, completing that district, and of about 200 square miles of forest in the northern portion of district Damoh.

(*d*) The classification of forest growth and soil of the area to be surveyed in detail.

183. The office of the party was inspected by the Superintendent, Trigonometrical Surveys, at Mussooree on 25th July 1895, who was thoroughly satisfied with everything he saw.*

BOMBAY PRESIDENCY.

NO. 17 PARTY.

184. This party remained under the charge of Lieutenant-Colonel J. R. Hobday, S.C., throughout the year, and was engaged, as in previous seasons, on the survey of forest tracts in the Bombay Presidency.

Personnel.

Lieutenant-Colonel J. R. Hobday, S.C., Officiating Superintendent, 2nd grade, in charge.
Mr. C. E. Tapsell, Extra Assistant Superintendent, 4th grade.
„ S. F. Norman, ditto ditto 6th „
„ C. A. Norman, ditto ditto 6th „

Surveyors and Sub-surveyors.

Gopal Vishnu, G. R. Bhopatkar, Govind Gopal, R. V. Joshi, N. V. Bhopatkar, V. G. Bhat, and 29 others.

185. The season's operations comprised :—

(1) Triangulation in the North Thana and Kolaba districts.

(2) Surveys on the 16-inch scale of *babul* reserves in the Poona and Ahmednagar districts.

(3) Surveys on the 8-inch scale of teak reserves in the North Thana, Poona, and Ahmednagar districts.

(4) Surveys on the 4-inch scale of ordinary reserves in the Poona and North Kanara districts.

186. The party took the field about the 1st November 1894, and returned to recess quarters at Poona about the end of May 1895.

187. In the Northern Circle, 200 square miles of supplementary triangulation and traversing in advance of detail survey were completed in sheets Nos. 135 and 136, in *taluka* Mahim, Thana district, whilst 55·5 square miles of the reserves in *taluka* Wada of the same district were topographically surveyed in sheet No. 162.

In the Central Circle, the following forest areas were surveyed :—

In Haveli *taluka*, Poona district, 159·35 square miles on the 4-inch scale, 6·89 square miles on the 8-inch scale, and 0·41 square miles on the 16-inch scale in sheets Nos. 166, 167, 198, 199, 232, and 233. In Kopargaon and Newasa *talukas*, Ahmednagar district, 23·83 square miles were surveyed on the 8-inch scale in sheets Nos. 259, 260, 290, and 291, and in Akola *taluka*, of the same district, 106·14 square miles on the 8-inch scale in sheet No. 229.

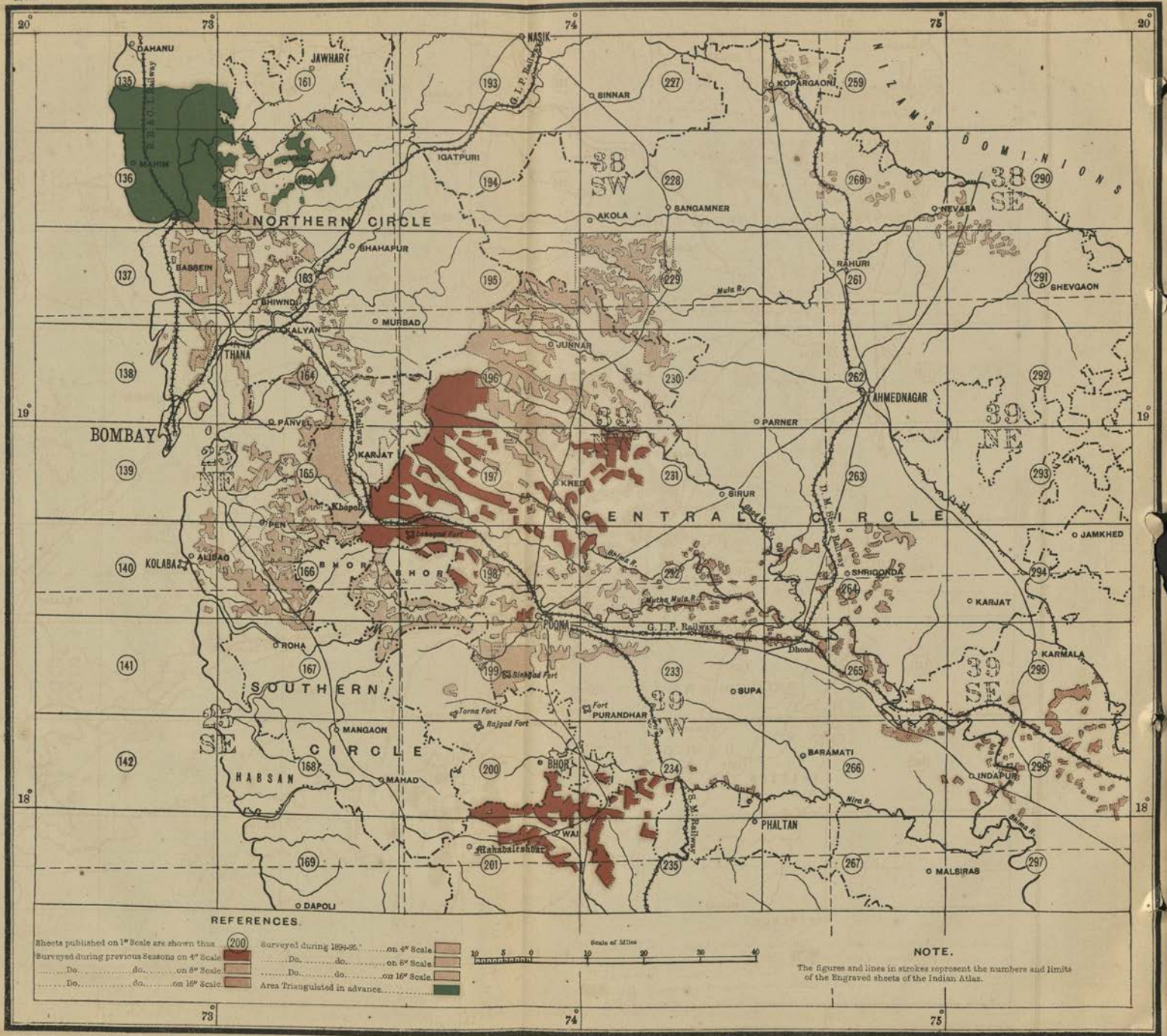
In the Southern Circle, 150 square miles of supplementary triangulation in sheets Nos. 139, 140, and 166 were completed and computed in the field,

* Captain Bythell reports very well of all his European assistants. The following members of the native establishment are also deserving of special mention :—
Gurdutt Sing, Kadir Sharif, Karimdad Khan, Ram Singh, Mahadeo Daji, Satto Charan Ghosal, Surjan Singh, Abdul Haq (1), Dharmu, Muhammad Zakaria, Syed Zille Hassain, and Syed Razi Hasan.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN AND CENTRAL CIRCLES.

1894-95. No. 17 PARTY.



REFERENCES.

Sheets published on 1" Scale are shown thus (200)

Surveyed during previous Seasons on 4" Scale

.....Do.....do.....on 8" Scale

.....Do.....do.....on 16" Scale

Surveyed during 1894-95.....on 4" Scale

.....Do.....do.....on 8" Scale

.....Do.....do.....on 16" Scale

Area Triangulated in advance

Scale of Miles

10 5 0 10 20 30 40

NOTE.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Reg. No. W. & I. D.—Dec. 95—300.

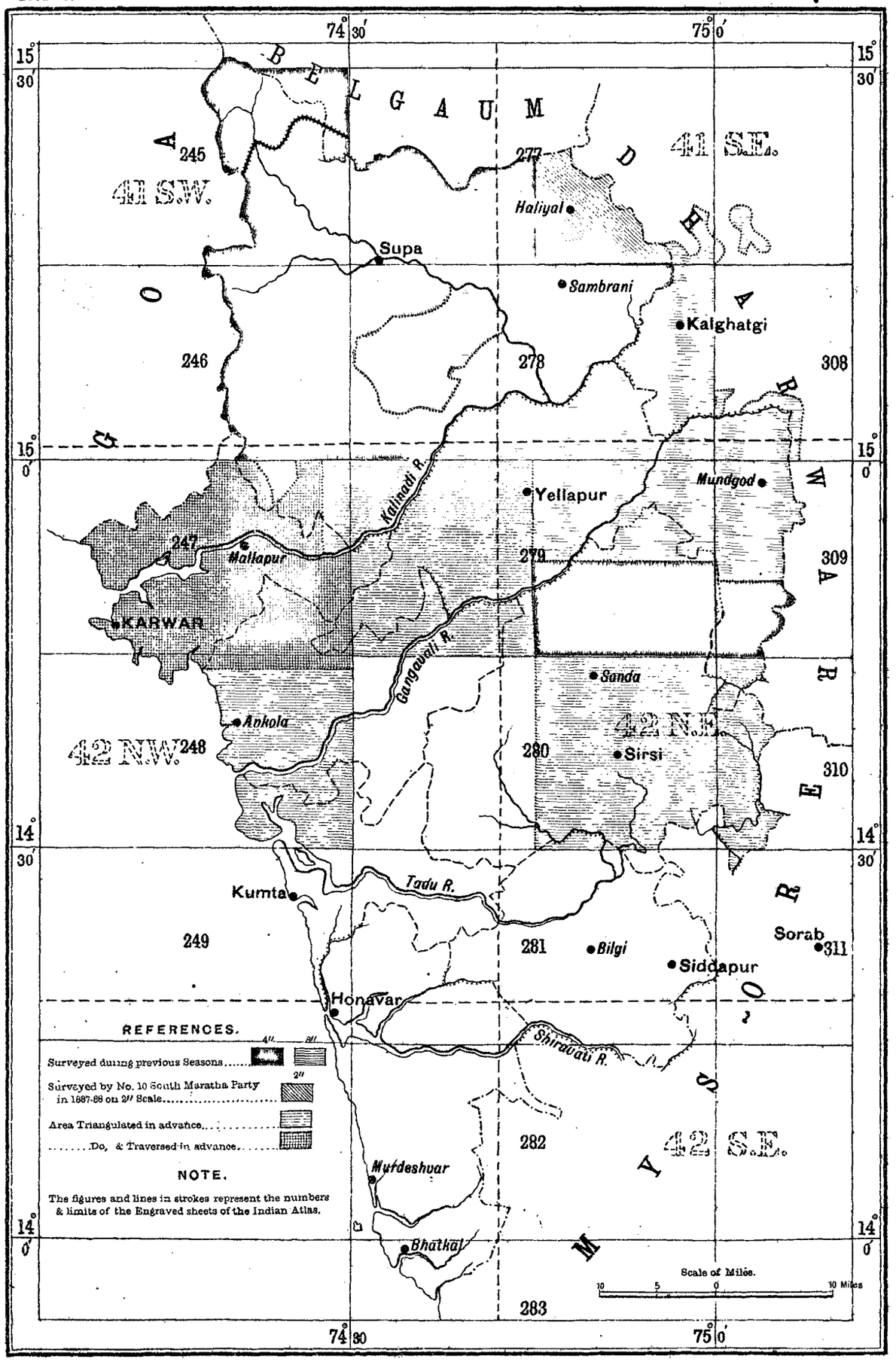
Photo., S. I. C., Calcutta.

No. 545-S. 95.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTHERN CIRCLE (N. KANARA).

1894-95. No. 17 PARTY.



Reg. No 333, S. T. D.—Dec 95.—550.

Photo. S. I. O., Calcutta

No. 546-S. 95.

whilst 725 square miles of triangulation in sheets Nos. 248, 279, 280, and 310, and 75 square miles of traversing were completed in North Kanara district, in advance of topography. The following forest areas were surveyed in detail in sheets Nos. 139, 140, and 166, *viz.*, 116·69 square miles in the Pen and Alibag *talukas*, thus completing the survey of the forest reserves in those *talukas* of Kolaba district.

188. The aggregate outturn completed on the various scales during the past and preceding field seasons are shown in the following statement:—

Description.	1893-94.	1894-95.
	Square miles.	Square miles.
Triangulation	465	1,080
Traversing	215	275
Topography, 4-inch scale	202	159
Ditto 8-inch „	222	285
Ditto 16-inch „	65	24

The decrease of area on the outturn of topography on the 4-inch scale, as compared with that of the previous year, is due to the fact that no detail surveys were undertaken in North Kanara during the season under report; and the decrease on the 16-inch scale, to the small number of sub-surveyors (two) that were available for this special work. On the other hand there is an increase of outturn on the 8-inch scale, and a very considerable increase of triangulation in advance of topography.

189. The average cost-rates of the surveys on the various scales, as compared with those of the previous year, are as follows:—

Description.	Scale.	1893-94.	1894-95.
		₹	₹
Triangulation	4 inches=1 mile.	10·8	8·8
Ditto	8 „ „	...	15·0
Traversing	4 „ „	12·6	29·5
Ditto	8 „ „	...	4·8
Topography	4 „ „	84·8	81·0
Ditto	8 „ „	156·4	140·3
Ditto	16 „ „	179·5	116·5

The above shows a diminution of cost-rates in every instance with the exception of the cost-rate of traversing on the 4-inch scale, the increase being due to the difficult nature of the country (North Kanara) and the expense of cutting rays through dense forest; also to the fact of the surveyor who was employed on the work being comparatively a new hand, this being his first attempt at traversing. The *modus operandi* of traversing which has hitherto been in vogue in this party was also found to be a laborious one, which will be modified in future with better results.

The large decrease in the cost-rate of 16-inch surveys is due to the absence of European supervision. These *babul* reserves being small blocks situated on the banks of the principal rivers of the Deccan, on flat ground and easy to survey, it was deemed sufficient to place a reliable native surveyor in charge of the work. The senior surveyor in the party, Gopal Vishnu, conducted these operations in a thoroughly satisfactory manner. The outer boundaries of the blocks were surveyed by him in person by plane-table circuits, with two chains of different lengths, whilst the interior details were filled in afterwards by his assistants. The 24 square miles surveyed on this scale were finally tested by 33 linear miles of check lines. The employment of native supervision on these surveys was explained to and approved by the Surveyor-General on the occasion of his annual inspection this year. It is hoped that the diminution of the cost-rate of these special surveys, the need for which the Conservator of Forests, Central Circle, has fully explained in his last administration report, will be approved of by the Imperial and Provincial Governments, who have hitherto

brought to notice their costliness. With an increase to the establishment of native surveyors in this party a still further decrease of the cost-rates of these 16-inch surveys may reasonably be expected.

190. The number of native surveyors in the party (27) is inadequate for the three European assistants who are appointed to supervise them; consequently, an application has been made to the Government of Bombay to raise the budget allotment from ₹71,000 to ₹76,000, or an addition of ₹5,000, which will provide for the entertainment of nine or ten more surveyors and their establishments in the field. This is really only an addition of ₹200 to the budget grant, as the annual allotment for the past six years has been ₹75,800. This proposed increase in the native staff, if sanctioned, cannot fail to accelerate the progress of the forest surveys, and at the same time to considerably diminish cost-rates.

191. The progress of the forest surveys in the Bombay Presidency, and consequently their cost-rates, depend upon a variety of circumstances, some of the most important being—

(1) The distance of the field of operations from head-quarters.
(2) The scattered nature and size of the forest blocks.
(3) The number of stones, cairns, or other permanent forest marks that have to be laid down on our maps with precision.
(4) The healthiness, or otherwise, of the localities under survey.
(5) The density of forest growth.

It is found that the cost-rates of a survey on any given scale vary in each district and forest circle, and such differences are accounted for by the above-mentioned circumstances. The causes which affect the progress and consequently the cost-rates of the surveys in the Deccan, or Central Circle, are items (2) and (3), as enumerated above. The cause affecting the progress of the surveys in the Konkan, *viz.*, in Thana and Kolaba districts, is item (4), whilst those which influence the rates in Kanara are those cited in items (1) (4), and (5).

192. The accuracy of the season's topography was tested by 187 linear miles of check lines, as well as by *in situ* examination; and the camps of the various detachments were visited by the officers in charge wherever operations were in progress.

193. The health of the party was good, with the exception of a few cases of sickness in the Konkan, in districts Kolaba and Thana.

194. During the recess, the fair-mapping and computations of the season's work were completed. In the Northern Circle, eleven sections on the 8-inch scale in district Thana were completed and sent to press. In the Central Circle eighteen sections on the 4-inch scale, six on the 8-inch scale, and one on the 16-inch scale in district Poona, and thirty-one sections on the 8-inch scale, and forty-four on the 16-inch scale in district Ahmednagar were also completed and sent to press, and in the Southern Circle, nineteen sections on the 8-inch scale in district Kolaba. The above sheets were all sent to the Government Photographic Office at Poona for publication. In addition to these, eight sections on the 2-inch scale in district North Kanara were prepared for reduction to half scale in the Calcutta office.

195. The programme for the ensuing field season is as follows:—

Northern Circle.—Supplementary triangulation and traversing in sheet No. 135 for 8-inch surveys in *taluka* Dahanu, Thana district, and continuation of detail surveys of the reserves in *talukas* Wada and Mahim, in the same district, in sheets Nos. 136 and 162. An attempt will also be made to demarcate the boundaries *pari passu* with the detail survey, the Forest Department undertaking to pay for the cost of erecting the necessary cairns, etc.

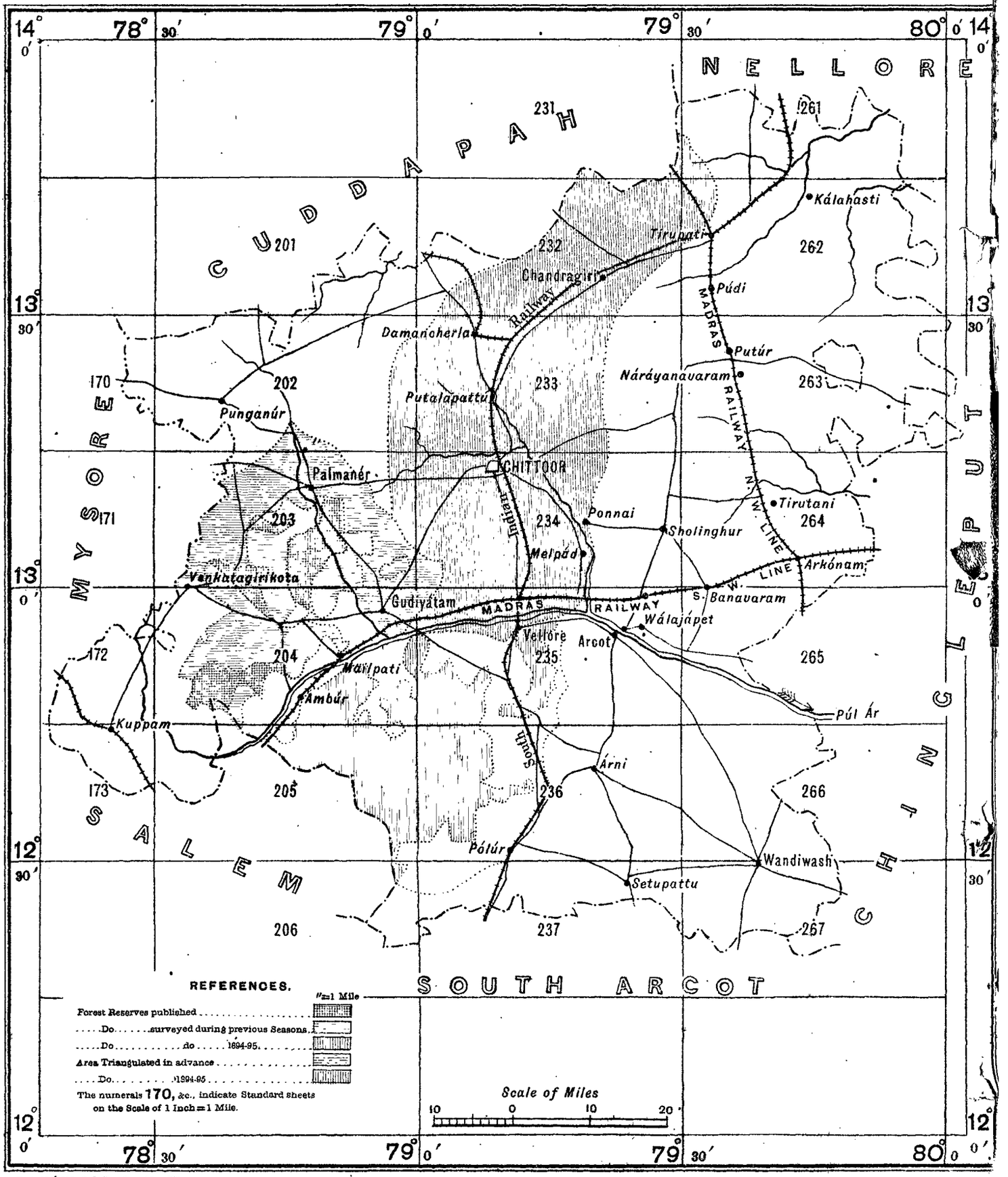
Central Circle.—Supplementary triangulation in advance of detail survey for the remaining teak reserves unsurveyed in *talukas* Akola and Sangamner, of Ahmednagar district, in sheets Nos. 194, 195, and 228. Detail survey of forest reserves on the 4-inch, 8-inch, and 16-inch scales in *talukas* Sirur, Purandhar, Bhimkadi, and Indapur, in sheets Nos. 199, 200, 231, 232, 233, 234, 264, 265, 266, 267, 296, and 297, and continuation of 16-inch surveys of *babul* reserves in the Ahmednagar district.

Southern Circle.—Triangulation of sheet No. 249, and the western halves of sheets Nos. 280 and 281 in Kanara district, and traversing in portions of

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE NORTH-ARCOT DISTRICT.

1894-95. No. 19 PARTY.



Reg. No. 332, S. I. D.—Dec 95.—550.

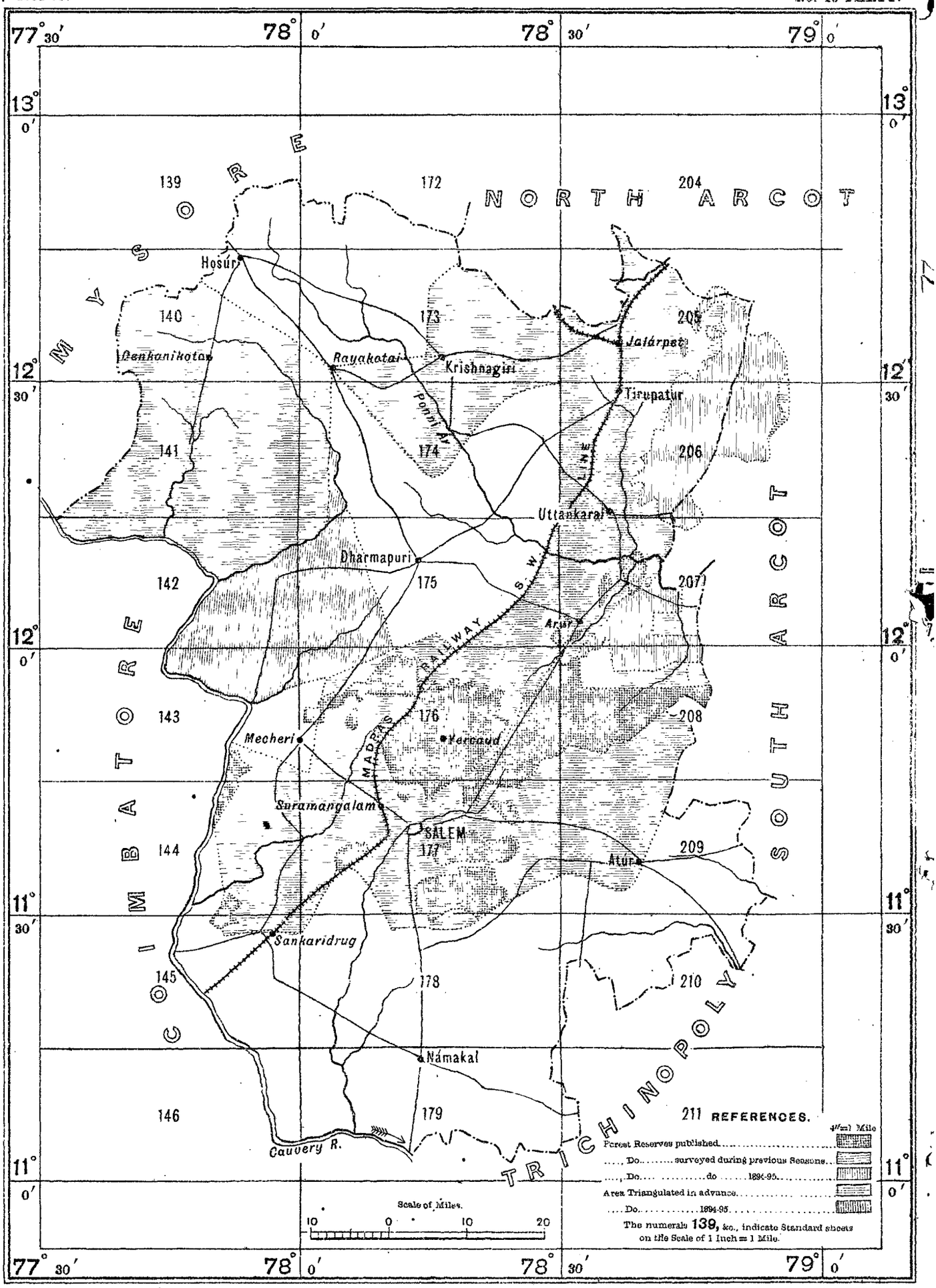
Photo. S. I. O., Calcutta

No. 549-S. 95.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE S.-ARCOT & SALEM DISTRICTS.

1894-95. No. 19 PARTY.



Reg. No. 332, S. I. D.—Dec 95.—550.

Photo., S. I. O., Calcutta.

No. 550-S. 95.

sheets Nos. 279, 280, and 310. Detail survey on the 4-inch scale of sheet No. 247 and the western half of sheet No. 279 in Kanara district.

196. The recess office of the party was inspected by the Surveyor-General at Poona in September 1895. During the inspection Lieutenant-Colonel Hobday explained his views with regard to the increase of the native establishment which was thoroughly approved of, and it is hoped that no difficulties as regards the consequent small increase to the budget will interfere with its introduction. That officer's long experience in topographical parties enables him to suggest changes that must result in increased efficiency and a reduction of the cost-rate.*

MADRAS PRESIDENCY.

No. 19 PARTY.

197. This party was employed during the season on the survey of forest reserves, etc., in the Salem, North Arcot, and South Arcot districts, on the 4-inch scale, in continuation of the work of previous seasons. Captain H. M. Jackson, R.E., continued in charge until the 8th July 1895, when he proceeded on special leave, and the charge was assumed by Lieutenant C. H. D. Ryder, R.E.

Personnel.

Captain H. M. Jackson, R.E., Deputy Superintendent, 1st grade, in charge up to 7th July 1895.
Lieutenant C. H. D. Ryder, R.E., Assistant Superintendent, 1st grade, in charge from 8th July 1895.
Mr. C. F. Hamer, Extra Assistant Superintendent, 4th grade.
„ H. Todd, ditto ditto, 4th „
„ R. Todd, ditto ditto, 6th „
„ J. H. S. Wilson, Sub-Assistant Superintendent, 3rd „

Surveyors and Sub-Surveyors.

Sher Shah, Bapu Jadu, Raghavayengar, Tiruvenkatsamy, Balaji Dhondiba, Govindaraju, Ramasamy Naidu, Anantarao Dhondiba, and 24 others.

198. As in previous years, the party was divided into three sections: No. 1, under Mr. R. Todd, was detailed for the extension of the triangulation in the Salem and North Arcot districts; No. 2, under Mr. C. F. Hamer, for the continuation of detail survey in the Salem district; and No. 3, under Mr. H. Todd, for similar work in the North Arcot district. Both the latter sections undertook, as before, the boundary traversing in their respective districts.

199. Field operations commenced in the first week in September 1894, and closed in the first week in March 1895.

200. The area triangulated amounts altogether to 1,900 square miles, and in addition 850 linear miles of forest boundary were traversed with the theodolite. The area surveyed in detail on the 4-inch scale amounts to 971 square miles, being the largest outturn yet recorded for this party. The increase is largely due to the employment of young hands who had hitherto been in training. The result of this increase to the effective strength of the establishment of native surveyors is a reduction of the cost-rate from Rs. 72-11-10 to Rs. 66-9-4 per square mile.

201. The country surveyed consists of the northern part of the Kalrayan range, the survey of which is now completed, and of the Javadi range lying between the three districts of Salem, North Arcot, and South Arcot. The character of these hills is very similar to that of the Kalrayans described in last year's report, of which indeed they are a continuation, separated only by a valley of about 6 or 7 miles in breadth. The slopes of the Javadis are fairly thickly wooded, the tops forming in several parts small plateaux, of elevation varying from a little under 2,000 to over 3,000 feet above sea level, which are extensively cultivated in parts. The whole of the range has been surveyed, including cultivated lands of all classes both on the hills and in the valleys intervening. Thus a complete map of the range has been obtained, from which all the information required by Government is at once available so far as the scale permits.

202. The whole of the work was examined by the Deputy Superintendent and the section officers, both during its progress and after completion.

* Lieutenant-Colonel Hobday reports that his assistants, Mr. Tapsell and the Messrs. Norman, gave every assistance in bringing the season's programme to a successful issue. Mr. S. Norman is a very capable officer, and seems to be thoroughly conversant in all details connected with the forest surveys.
The surveyors, with two exceptions, worked well asusual. Those deserving of mention are Surveyors Gopal Vishnu, G. R. Bhopatkar, and Sub-Surveyors R N. Joshi and Yemla Piraji.

203. The country surveyed during the season is notoriously unhealthy. Hardly one of the native surveyors escaped without more or less fever, and most of the *khalásis* were attacked at one time or another. One only of the latter died, but many deserted through fear of sickness. The work was thus in some instances considerably impeded.

204. During the recess, the various computations were brought up to date, and the fair mapping of the area surveyed was completed with the exception of a few sheets in the Yellagiri hills, which were only partially surveyed. Fifteen maps held back last year on account of questions of demarcation were sent in during the recess, those questions having been settled with the Forest Department. In all 47 sheets were sent in, including 6 completing the Kalrayan range series, 8 of the Javadi range in the Salem district, 12 of the same range in the North Arcot district, and 6 in the South Arcot district, besides the 15 sheets referred to above.

205. The recess office of the party was inspected by the Surveyor-General at Bangalore in August 1895, who was well satisfied with the state of efficiency in which he found the party, and with the progress made during the previous season.

206. The programme for the ensuing season, as approved by the local authorities, provides for the continuation and completion of the triangulation in the Salem district and its commencement in the Kurnool district. The detail survey in the North Arcot district will be completed and that in the Salem district continued.*

LOWER BURMA.

No. 20 PARTY.

207. The programme of the party consisted of the detail survey of the Okkan group of reserves in Hanthawaddy district and of that part of the Paonglin reserve in Pegu which had been traversed in the previous season, and the triangulation and traverse survey of the remainder of the Paonglin reserve and the Pyinma reserve in Pegu, and of the Pyukun reserve and a large tract of unreserved forest adjoining in Toungoo, and of a portion of the Aingdonkun reserve in Shwegyin.

Personnel.

Captain P. J. Gordon, s.c., Officiating Deputy Superintendent, 2nd grade, in charge from 1st November 1894.
Mr. W. A. Wilson, Extra Assistant Superintendent, 1st grade.
„ P. White ditto ditto 6th „
„ R. F. Warwick, Sub-Assistant ditto 1st „
„ A. Ewing, ditto ditto 1st „
„ H. A. Charrier, ditto ditto 2nd „
Twenty-nine surveyors and sub-surveyors.

208. The party left recess quarters at Bangalore in the middle of November. Field work was commenced in the first week of December 1894 and the last squads left their ground in the last week of May 1895.

209. The traverse work was under the charge of Mr. Wilson and resulted in a considerably larger outturn than in former seasons, *viz.*, 740 linear miles, covering an area of 500 square miles. The area was divided into 86 blocks of an average area of 6 square miles. The work was connected with thirteen trigonometrical stations and checked by 130 sun azimuths, giving good results. Vertical angles were taken as well as horizontal ones, and although this was not done till late in the season 1,400 reliable heights of traverse stations were obtained.

210. Mr. White was in charge of the triangulation and brought in an area of 440 square miles. He observed at thirteen stations and connected his work with four Great Trigonometrical points.

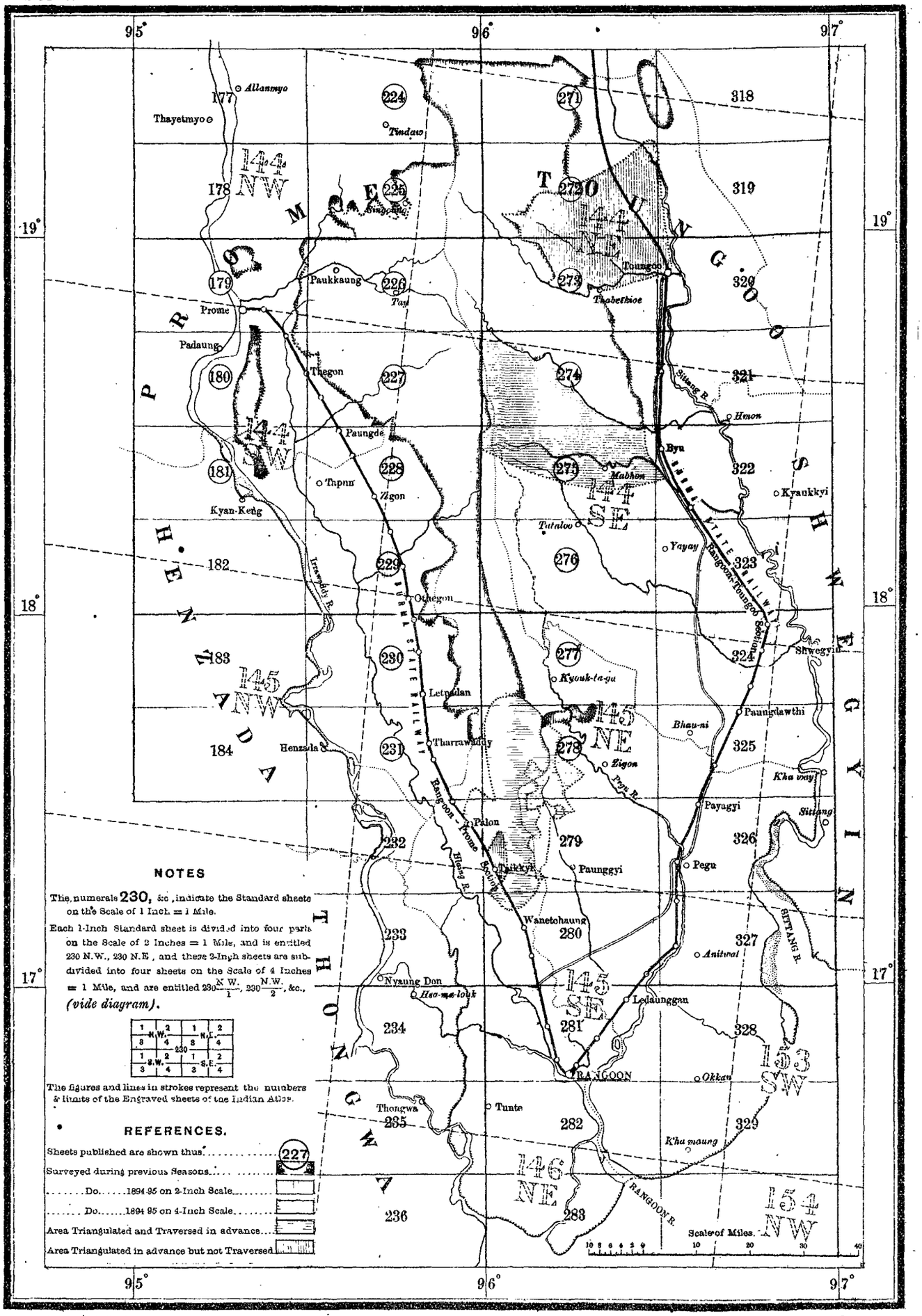
211. The outturn of detail survey on the 4-inch scale was 339 square miles and on the 2-inch scale 36 square miles. This does not include revision surveys of the present and former seasons. Mr. Warwick was in charge of the detail camp and was assisted by Mr. Ewing, while Mr. Charrier was employed in surveying a few gaps left from the previous season in Toungoo, and in

* Captain Jackson, who held charge during the field season, reports that the large outturn is chiefly due to the good supervision exercised by all the assistants. Both Messrs. C. F. Hamer and H. Todd are highly commended for the manner in which they performed their duties both in the field and in recess.
Of the Surveyors, special mention is made of Sher Shah, Bapu Jadu, Balaji Dhondiba, Anantarao Dhondiba, Abdul Khalik, and Eknath Battu.

BURMA SURVEY.

INDEX TO THE FOREST SURVEY IN LOWER BURMA.

1894-95. , No. 20 PARTY.



NOTES

The numerals 230, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are subdivided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled $230\frac{N.W.}{1}$, $230\frac{N.W.}{2}$, &c., *(vide diagram)*.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus..... 227

Surveyed during previous Seasons.....

.....Do.....1894-95 on 2-Inch Scale.....

.....Do.....1894-95 on 4-Inch Scale.....

Area Triangulated and Traversed in advance....

Area Triangulated in advance but not Traversed....

Reg. No. 85[illegible] I.D.—Dec 95—560.

Photo., S. I. O., Calcutta.

No. 547-S. 95.

revision. The detail survey was systematically tested by the officer in charge and by two assistants. The classification of forests and soils was undertaken for the first time by the party with satisfactory results. In the heavy jungle it has hitherto been the practice to align the forward flag by means of sound signals. This year each forward flagman was given a small mirror with which he flashed the sun's rays in the direction of the surveyor; this was almost always more or less visible even through the thickest jungle and gave better results than where the position of the flag was estimated by sound only.

212. The cost-rates were somewhat reduced, as is shown by the following table comparing this season's work with that of 1893-94:—

Nature of work.	Cost-rates per square mile		Remarks.
	1893-94.	1894-95.	
	ℛ	ℛ	
Triangulation	35 7 7	30 1 1	* The increased rate in 1894-95 is due to the survey being performed by European agency.
Traversing	128 12 3	94 0 1	
Detail survey, 4-inch scale . .	153 2 11	153 8 1	
Ditto 2-inch „	83 10 9	179 9 4*	

Assuming two square miles of 2-inch survey to equal one square mile of 4-inch survey, the cost-rate of the combined operations for 1894-95 is ℛ282 as against ℛ321 in 1893-94.

The rates continue high as compared with similar work in India for the reasons adduced in last year's report, *viz.*, the extra cost of importing labour; the large establishment required for clearing; higher pay of all classes; and purchase and upkeep of elephants for transporting provisions. The utmost economy is practised and results prove that steps are being taken in the right direction towards reducing cost-rates.

213. The country is a mass of low hills, thickly-covered with jungle, and triangulators, traverse surveyors, and plane-tablers alike have to spend a great part of their time in laboriously cutting paths in the jungle. The climate is trying: in the beginning of the season it is cold at night and hot in the day time. In March and April the hot weather sets in and everything is parched. The first rains commence in May and after that little more work can be accomplished. The work is monotonous in the extreme owing to the unpopulated state of the country.

214. The health of the party was on the whole good. There were the usual fevers and other ailments due to climate, but there were only two deaths in the field from this cause. Besides these, two men died on the voyage to and from India and there were two deaths from accidents—a *khalási* being carried off by a tiger and a *mahout* trampled to death by a young elephant belonging to the party.

215. As usual arrangements had to be made to transport supplies of provisions to the outlying camps, as none were procurable in the forests. This, though troublesome, has its advantages, as it allows of food of good quality being supplied to the men.

216. Computations were brought up to date during the recess. The mapping of fifteen standard 4-inch sheets containing the greater part of this season's work was completed and portions of four others containing revision work, &c. Traces of forests and soils of all work to be published were also prepared. All available surveys in sheets Nos. 272 and 273 were drawn on the scale of 2 inches to 1 mile for reduction to 1-inch standard sheets.

217. The programme for next season consists of the detail survey of all country already traversed and the traverse and triangulation of about 500 square miles of the forest reserves in Shwegyin and Pegu districts. This is in conformity with the original programme of the party. The work now remaining to be done adjoins and will be connected with former surveys in Shwegyin and Pegu.

218. Colonel Strahan, as Deputy Surveyor-General, inspected the party in the field at Byu in January 1895 and as Surveyor-General in recess quarters

at Bangalore in August, and was thoroughly satisfied with the general arrangements and the progress made by the party.*

OPERATIONS OF THE FOREST SURVEY BRANCH.

219. The Forest Survey Branch, the administration of which is under the control of the Inspector-General of Forests, remained under the supervision of Mr. W. H. Reynolds, Superintendent of Forest Surveys, throughout the year.

220. In continuation of the previous season's operations, field work was carried on in six districts of the Central Provinces, in the Punjab, in Oudh, and in Upper and Lower Burma; and a surveyor was also deputed to continue the re-alignment of the Bhutan-Goalpara boundary. In addition to the above, field operations were extended into the Bahraich district in Oudh; the Saugor district in the Central Provinces; Lalitpur in the North-Western Provinces, and Chamba in the Punjab. The operations in each province will be reported on separately.

CENTRAL PROVINCES.

Personnel.

Mr. E. Litchfield, Officiating Deputy Superintendent, 2nd grade.
„ T. S. Marten, Extra Assistant Superintendent, 6th grade.
„ J. Marten, Officiating Extra Assistant Superintendent, 6th grade.
„ C. Litchfield, Sub-Assistant Superintendent, 2nd grade.

221. Four detachments were employed during the year on field operations in the Central Provinces. The forests operated on were those in the districts of—

(i) Nagpur with Seoni and Chindwara.
(ii) Narsinghpur and Saugor.
(iii) Raipur, and
(iv) Balaghat.

Each of the detachments worked under the immediate supervision of an European assistant, as shown in the margin.

222. The several survey detachments were in the field early in December and returned to recess quarters in June.

With the exception of Saugor, the survey of the forests in the districts noted above was in continuation of the operations of the previous year. In accordance with the sanctioned programme, the survey of the Saugor forests was taken up by the Narsinghpur detachment on completion of the work in that district.

223. The areas surveyed by each detachment and the cost-rate per square mile of each branch of the work are given in the following statement:—

Forest Divisions.	Triangulation.		Traversing.		Levelling.		Topography, chiefly on 4-inch scale, including forest growth records.	
	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.	Linear miles.	Cost-rate.	Area in square miles.	Cost-rate per square mile.
		₹		₹		₹		₹
Nagpur with Seoni and Chindwara .	683	9·1	...	...	...	...	251	51·6
Narsinghpur and Saugor . .	250	9·6	...	...	...	...	186	54·5
Raipur . .	...	...	8	15·0	135	10·0	175	57·8
Balaghat . .	...	...	...	...	...	...	246	35·8
Totals .	933	...	8	...	135	...	858	...

* Captain Gordon reports that of his assistants, Messrs. Wilson, White, and Warwick managed the camps they were in charge of to his satisfaction and Mr. Ewing proved himself an able surveyor. Of the Surveyors, Moung Kyaw-Nyein, Sharfuddin, and Sultan Mohamed did good detail, and Zahur Hasan and Janak Singh good traverse work.
In office, Maung Haung Hpo Nyein was the only draftsman deserving of mention.

224. Of the area surveyed in detail, 712 square miles were executed on the 4-inch scale, and 146 square miles along the forest boundaries were surveyed on the 16-inch scale. The outturn of the previous season was 597 square miles on the 4-inch scale and 111 square miles on the 16-inch scale.

225. In Raipur and Balaghat districts no triangulation was done, as this branch of the work was sufficiently in advance for the topographical survey, nor was it necessary to run any additional traversing in any of the districts except Raipur.

The triangulation in the Narsinghpur and Saugor districts was done by Mr. T. S. Marten and that in Nagpur, Seoni and Chindwara was done chiefly by Mr. Nichol; Mr. E. Litchfield did a portion of the Nagpur triangulation.

In the denser parts of the Raipur forests where it was not possible to fix trigonometrical stations, it was found necessary to carry on levelling operations for purposes of running instrumental contours.

226. The topographical work was tested by running 420 linear miles of check surveys through it and the instrumental contours, which were run at 250 feet vertical distances throughout the work, also answered as an additional check on the detail survey.

227. Considerable progress has been made with the 4-inch mapping of the forests, and a vast amount of work has been got out of hand. During the year 62 sheets have been published, 38 sheets are in the press and 57 are in different stages of completion.

228. The total expenditure on the above operations was ₹57,393 of which ₹52,176 was on account of surveys that are in progress and ₹5,217 was expended on account of drawing and photo-zincographic charges for forest maps of the Bhandara and Jabalpur divisions or of areas previously surveyed.

229. The average cost-rate of the detail surveys, including the mapping, was ₹50 per square mile, as compared with ₹54 in the previous year.

230. As was done in previous years, the 16-inch boundary surveys were compared, as the survey progressed, with the settlement records and all differences in boundaries were brought to notice and discrepancies were duly settled by the Settlement Department in consultation with the Forest Department.

231. With the exception of the Balaghat detachment all the survey detachments working in the Central Provinces suffered more or less from malarial fever and dysentry, and several *khalàsis* died after only a few day's illness. The health of the Balaghat detachment was exceptionally good, and hence the large outturn of field work by this detachment.

232. Mr. W. H. Reynolds, Superintendent of Forest Surveys, visited in turn each of the field parties; he was in the Central Provinces from the 28th January to the 13th February 1895.

PUNJAB.

233. At the close of the previous year a small but remote tract of 141 square miles in the south-east corner of the Bashahr State was left unsurveyed. As this was a most intricate piece of work and difficult of access, Mr. E. Litchfield was deputed to complete it. He left Dehra during the rains and after a very tedious march up the Bhagiratee Valley, and a very trying time at elevations of from 16,000 to 18,000 feet, he completed the work and returned to head-quarters in November or just after the commencement of the survey year under report.

234. The areas surveyed were 141 square miles on the 1-inch scale and a small tract of 5 square miles of forest land which had been omitted in the previous year's operations. This completes the survey of the Bashahr State.

235. The expenditure incurred in the season's operations, including the 4-inch and 1-inch mapping, was ₹5,685, of which ₹275 was spent on 4-inch work. The cost-rate of the 1-inch work is, therefore, ₹27·5 per square mile, which is somewhat higher than last year's rate; this is due to the many difficulties that had to be encountered in completing the work, amongst which were the great distance that had to be got over before arriving at the field of operations, the exceeding elevations of the tracts under survey, the carriage of supplies and even fuel for the survey camp and the long return march to head-quarters.

236. On completion of the Bashahr survey, the survey of the Chamba State was taken in hand, in accordance with the sanctioned programme of work.

Triangulation was taken up during the autumn in the tracts bordering the Gurudaspur district, and as soon as the snow admitted of it triangulation was extended into the higher hills bordering on Jummoo.

The detail surveyors took the field in May or as soon as the triangulation was sufficiently advanced to allow of their breaking ground.

237. The following statement exhibits the areas completed during the year, as well as the cost-rates of the work :—

State.	Triangulation.		Topographical Survey.			
			4-inch scale.		1-inch scale.	
	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.
		₹		₹		₹
Chamba	761	7·6	9	60·0	141	21·1

238. The total expenditure on the above operations was ₹9,312.

239. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was with the Chamba detachment from the 15th May to the 19th July personally directing and supervising the survey operations.

North-Western Provinces and Oudh.

240. In the North-Western Provinces and Oudh two detachments of the Forest Survey Branch were employed throughout the year, *viz.* :—one in the Lalitpur district and the second one in the districts of Bahraich and Gonda in Oudh.

241. The survey of the forests in the Lalitpur district was ordered in November 1894 and Mr. B. R. Hughes, Sub-Assistant Superintendent, Survey of India Department, was temporarily transferred to the Forest Survey Branch to supervise the work.

The detachment took the field on the 30th November, and returned to head-quarters early in June.

242. During the early part of the field season triangulation and plane-tabling were carried on in the forests situated in the south of the district, and on completion of this locality, the surveyors took up the northern forests, but the latter work was not completed by the close of the season.

The triangulation was done entirely by Mr. Hughes, and the supervision of his detachment was all that could be desired.

243. The following statement exhibits the areas surveyed during the year and the cost-rates of the work :—

Forest Division.	Triangulation.		Topographical Survey 4-inch scale.	
	Area in square miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.
		₹		₹
Lalitpur	247	9·4	115	55·3

244. The expenditure on the above work, including the season's mapping, was ₹8,702 ; this includes a small sum of ₹10 on account of Jaunsar forest maps.

245. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in the Lalitpur district from the 19th to 28th January, and satisfied himself that the field work was being efficiently conducted.

246. The forest surveys in Oudh were in continuation of the operations of the previous years; the survey detachment took the field on the 9th November and returned to head-quarters on the 11th June.

247. As was the case for several years past, the detachment worked under Babu Oodey Sing, a surveyor of considerable experience, and a man who has proved himself to be trustworthy.

The Superintendent was in Oudh from the 8th to the 13th December, and again visited Oudh and inspected the field work of the detachment from the 3rd to the 13th of March.

248. During the early part of the field season, traversing was carried on in the Gonda district, and in February the traverse section moved into Bahraich. The topographical surveyors followed the traverse section and also worked in the Gonda and Bahraich districts.

The traversing is sufficiently in advance for the coming season's plane-tabling.

249. Throughout the field season levelling operations were carried on in the Bhira forest with a view to ascertaining the simplest method of draining the *phantas* or grass lands which are situated in the heart of the *sâl* forests.

250. The re-alignment of the Nepal boundary touching on the Kheri forests was attempted, but after the surveyors were at work for about a month the work was stopped owing to the interference of the Nepalese authorities. The question of this boundary is still under the consideration of Government, and in the meantime the publication of the maps of the Kheri forests is held in abeyance.

251. The following statement shows the season's outturn, and the cost-rates of each class of survey:—

Forest Division.	Traversing.		Levelling.		4-inch Topography and forest growth records.	
	Area in square miles.	Cost-rate per square mile.	Linear miles.	Cost-rate per square mile.	Area in square miles.	Cost-rate per square mile.
		₹		₹		₹
Gonda . .	507	7·3	...	...	358	17
Bahraich . .						
Bhira . . .	...	...	121	6·4	...	...
Totals .	507	...	121	...	358	...

252. The detail survey was checked by running 298 linear miles of *partal* or check surveys throughout the work.

253. The total expenditure incurred on account of the Oudh surveys was ₹10,594; included in these figures is a charge of ₹1,394 which was expended on account of publishing maps of surveys which were completed in previous years.

254. The same system was adopted as was done in previous years with reference to the traversing, that is to say that all masonry pillars, in or near the forests, for which revenue survey numerical data were available, were used as initial and closing stations for the forests survey traversing, and the final results of the traversing were computed in the same terms as the Oudh revenue surveys.

Burma.

255. The operations of the Forest Survey Branch in Burma were in continuation of those of the previous year.

256. Two detachments were employed, *viz.*, one in the Salween division of Lower Burma which worked under the general supervision, while it was in his division, of Mr. T. A. Hauxwell, Deputy Conservator of Forests, and later on by Mr. G. F. R. Blackwell, and the second was employed in the Pyinmana division of Upper Burma under the general supervision of Mr. C. E. Muriel, Deputy Conservator of Forests.

LIBRARY

257. Both detachments commenced field operations early in December and returned to head-quarters in June.

258. The following statement exhibits the areas and the cost-rates of each class of survey :—

Forest Division.	Traversing.		Topography 4 inch scale and forest growth records.	
	Linear miles.	Cost-rate per mile.	Area in square miles.	Cost-rate per square mile.
		₹		₹
Salween . . .	...	...	76	89·2
Pyinmana . . .	51·2	26·2	195	88·9
Totals .	51·2	...	271	...

The same remarks regarding the low cost-rates in Burma that were made in para. 214 of last year's report are applicable again this year.

259. The expenditure on the above operations, including the season's mapping, was ₹26,089, as against ₹29,095 in the previous year.

260. The detail survey was checked partly *in situ* and partly by running 225 linear miles of check surveys after the topography had been completed.

261. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was with the Upper Burma detachment from the 22nd December to the 4th January and from the 6th to the 13th January he was with the Lower Burma detachment and satisfied himself, in each case, that suitable arrangements had been made for the several survey camps and that the survey operations had been fairly and satisfactorily started.

262. Further particulars of the work carried on by the Forest Survey Branch, and index maps illustrating the same, will be found in the Report on the operations of the Branch published under the direction of the Superintendent, Forest Surveys.*

CADASTRAL SURVEYS.

BENGAL AND BIHAR.

Nos. 2 and 8 Parties.

263. These parties were engaged, as in the previous season, on the traverse and cadastral survey of various temporarily settled tracts and Government and private estates in Bengal and Bihar. The whole of the operations were under the supervision of Captain G. B. Hodgson, S. C., excepting those in the Chaurasi and Tantibunia estates, which were supervised by Captain J. M. Fleming, S. C.

264. The operations of the parties comprised the following :—

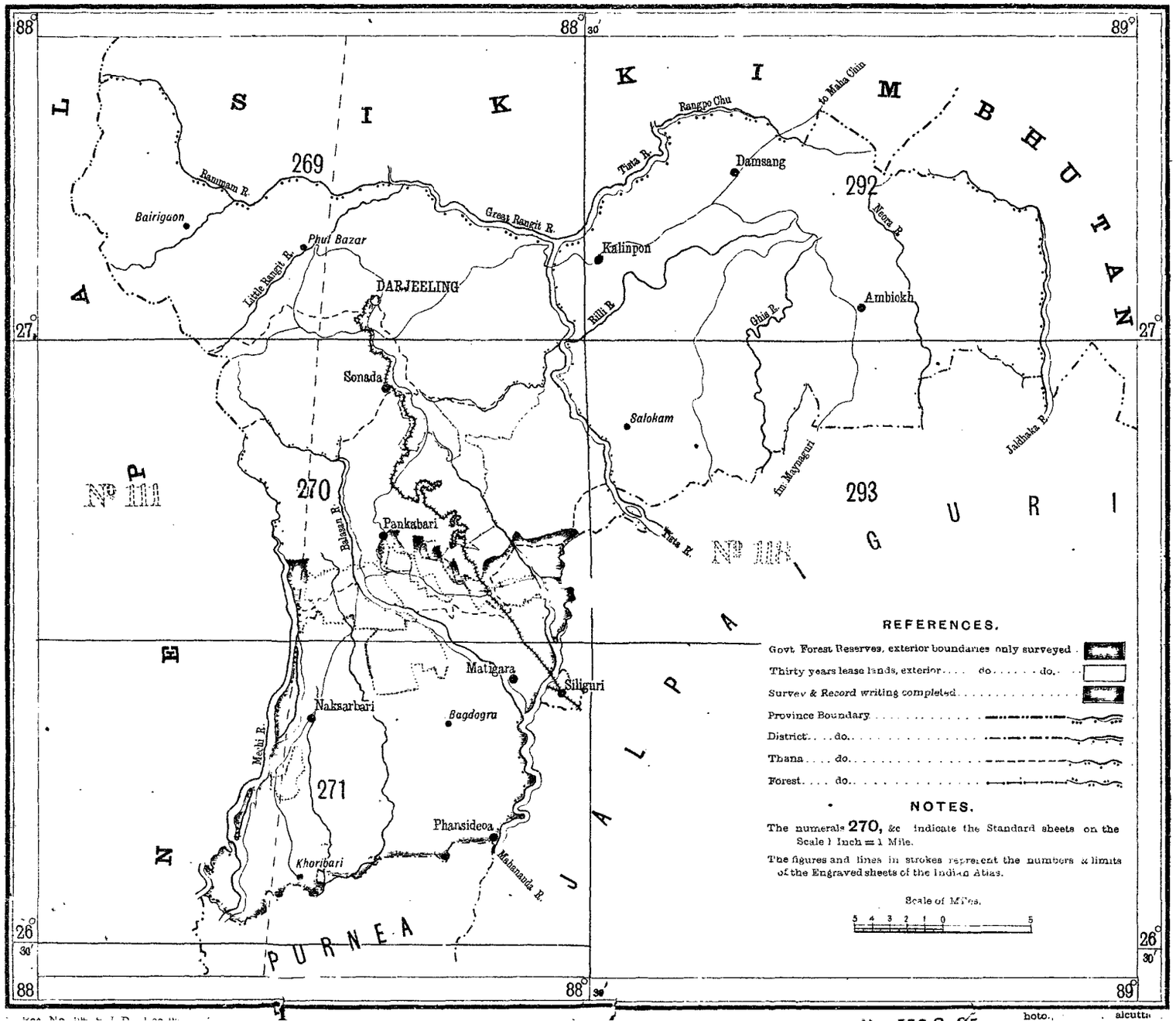
(1) Traverse and cadastral survey of the Tarai Jotes, district Darjeeling.
(2) Traverse and cadastral survey of the Palamau estate, district Palamau.
(3) Traverse survey of the Kolhan estate, district Singhbhum.
(4) Cadastral survey of the Government estates, district Gaya.
(5) Cadastral survey of the Tikari estates, districts Gaya and Patna.
(6) Traverse and cadastral survey of the Chaurasi estates, district 24-Parganas.
(7) Traverse and cadastral survey of the Tantibunia estate, district Khulna.

The operations of each detachment will be described separately.

* Mr. Reynolds reports that great credit is due to all his European assistants, who have one and all worked excellently and to his entire satisfaction.
Of the Native establishment the following are specially mentioned : Babu Kali Nath Kar, Pundit Salig Ram, Oodey Singh and Bhup Singh.

BENGAL SURVEY.

1894-95. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT DARJEELING.** Nos 4 & 5 PARTIES.



REFERENCES.

Govt. Forest Reserves, exterior boundaries only surveyed

Thirty years lease lands, exterior.... do..... do.

Survey & Record writing completed

Province Boundary

District....do.

Thana....do.

Forest....do.

NOTES.

The numerals **270,** &c indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

5 4 3 2 1 0 5

No. 556-S. 95. hoto., alcutta

SURVEY OF THE TARAI JOTES, DARJEELING DISTRICT.

265. The Darjeeling Terai *jotes*, numbering 819 and comprised in 19 *mauzas* in *parganas* Pattarghatta and Hatighisa, came under the operations of the settlement survey in 1877—79, when a settlement was made with the *jotedars* for a term of 15 years. The settlement expired on the 31st March 1895.

When the revenue survey of the Darjeeling Terai was undertaken in 1863—65, only the cultivated tracts were demarcated as *jotes*, the remaining area being parcelled out in blocks, under the designation of (*a*) Government excess land, (*b*) Government forest reserves. The excess lands were brought under settlement between the years 1866 and 1871 as grants held on 30-year leases, the number of grants being 33, with an aggregate area of 28,639 acres, or 44·75 square miles. Of this area 25,387 acres are included in tea gardens, the remaining 3,252 acres being under ordinary cultivation. The existing settlement expires on dates ranging between 31st December 1895 and 31st March 1897, and a re-survey was accordingly ordered by a Gazette notification dated 20th November 1894.

Personnel.

Mr. J. McHatton, Extra Assistant Superintendent, 5th grade, in charge.
„ P. C. H. Smart, Sub-Assistant Superintendent, 1st grade.
1 head inspector.
8 inspectors.
3 sub-surveyors.
90 *amins*.

The following was the season's programme:—

(1) Survey and record-writing of 196 square miles.
(2) Survey of exterior boundaries only of 33 square miles, comprising grants settled under the 30 years' lease rules.

266. In season 1878-79 a traverse survey, aggregating 236 linear miles with theodolite and 63 linear miles with prismatic compass, was carried out in the Darjeeling Terai by the late Captain Harman, R.E. These traverses did not follow the boundaries of *jotes* but were run along the principal roads, and the tri-junctions were incorporated therewith, as far as possible, by means of intersections. When the present re-survey of this tract was decided on by Government, it was not intended that a fresh traverse survey should be undertaken, but that the points fixed by Captain Harman should be utilised as a basis for the 16-inch maps.

267. Of Captain Harman's data, only that portion was utilised which refers to his theodolite traverse, the values derived from his prismatic compass survey not being considered sufficiently accurate to be adopted as the basis of a large scale survey. On completion of the plotting it was, however, found that out of a total of 269 sheets, comprising the entire area under survey, only 90 were covered by Captain Harman's points, and it therefore became necessary to throw a network of fresh traverses over the area covered by the remaining 179 sheets. The object desired was to undertake the minimum amount of traverse consistent with professional requirements, and with this end in view it was decided (*a*) to group together on the same sheet as many *jotes* as possible, and (*b*) to adopt as the polygonal unit a group of such sheets, the periphery of the polygon to embrace the sheets in such a manner as to ensure the traverse lines running through the middle of each sheet, irrespective of boundaries, but all tri-junctions of *jotes* falling near the alignment to be adopted as stations as far as possible. The object in running the traverses through the middle of each sheet was to eliminate accumulation of error in the detail survey by enabling the *amins* to throw out their triangulation by chain or by intersections with the sight rule on both sides outwards from this base. A main circuit was run round the entire area covered by the operations of the settlement survey of 1879—81. This was done to afford a check on the gross area of the *jotes*.

268. The demarcation was done by the *jotedars*, and was found on the whole to agree fairly well with the settlement survey of 1879—81. With regard to the demarcation of the 30-year lease grants, some difficulty was experienced at first owing to the usual notices not having been served; but as soon as this was done, the managers not only demarcated and cleared their boundaries, but even supplied coolies at their own expense, and this help enabled the traverse survey of these grants to be completed rapidly.

269. The season's operations cover an area of 231 square miles, of which about 76 square miles, although falling within the exterior limits of main circuits, are covered by Captain Harman's data, and should not therefore, strictly speaking, be considered as a part of the present operations. Of this area, 210 square miles have been surveyed cadastrally, and the remaining 21 square miles represent the area of tea grants held under the 30-year lease rules, of which the detail survey was not completed this season.

270. There are 4,004 traverse stations. The mean variation of the magnetic needle was found to be 2° 27′ east. Connections were made with eight Great Trigonometrical stations.

271. A comparison of the boundaries of the Government forest reserves has been made with Johnson's survey of 1863—65, and the differences have been shown in blue on the 16-inch maps of the present survey. The result of the comparison between the two surveys shows that on the whole boundaries agree fairly well.

272. The total cost of the traverse survey is R2,462, but this amount includes R50 on account of the survey of the Western Duars Railway line. The cost-rate per square mile is R15·9.

273. The cadastral survey was commenced on the 8th December 1894, and closed on 10th March 1895.

It was originally intended to employ on the Darjeeling Terai survey the establishment of Bengali *amins*, who had worked so successfully in the Tippera district during the past two seasons; but on being ordered to proceed to the Terai these men showed a reluctance to go there, probably on account of its reputed unhealthiness, and eventually only 33 reported themselves at Siliguri. It, therefore, became necessary to import foreign *amins*, and 57 Hindustanis were accordingly entertained, in order to complete the establishment. Fifty more Bengali *amins* were subsequently employed when the work of record-writing commenced in January 1895.

274. The outturn of detail survey and record-writing (*khanapuri*) for the season is shown in the following statement:—

District.	Cadastral Survey and Record-writing.				
	Class.	Number of jotes.	Number of blocks.	Number of helds.	Area in square miles.
Darjeeling	Lands held on 15 year leases.	818	...	105,992	196·3
	Lands held on 30 year leases.	...	60	1,686	12·1
	Bazar and government *khas* lands.	...	18	1,072	1·5
	Total	818	78	108,750	209·9

275. It was found impossible to plot the stations of the new supplementary traverses always previous to the cadastral survey. In such cases triangulation by sight rule from a carefully measured line was permitted to be thrown out laterally in both directions. The triangles were made as equilateral as possible, and this work was carried out under the personal direction of Mr. McHatton and his assistant. In some places sight rule traverses had to be resorted to, and where such was the case, special precautions were likewise taken to ensure as much accuracy as possible. Two traverses were first run across the sheet, dividing it into four sections as nearly equal as possible, and the extremities of these cross traverses were utilised as fresh points of departure in each of the four sections. The points fixed with the theodolite were plotted on these sheets after the detail survey was completed, and the work of the *amins* has on the whole stood this severe test remarkably well.

276. The survey of the 30 years' lease lands was only decided on late in the season, and even early in January 1895 the officer in charge was requested

by the Joint Magistrate, Kurseong, not to undertake the detail survey of any tea grants pending further orders. The Deputy Commissioner was of opinion that, before a detail survey of these lands could take place, it would be necessary to ascertain whether the private maps of the tea gardens were sufficiently accurate and up to date to admit of their being accepted as the basis for a resettlement, and the Joint Magistrate was requested to collect as many of these maps as possible and to report the result. Mr. McHatton was ordered to examine these maps and reported that—

(*a*) out of a total of 60 grants, the maps of only eight had been lodged by the Managers, and of these, only five were on the scale 16 inches = 1 mile;

(*b*) that it was impossible to tell whether these maps were sufficiently accurate and up to date unless they were tested; that the labour involved in testing them would be as great as in making an entirely fresh survey; and

(*c*) that a boundary survey of these grants had already been made, and the expenditure incurred thereon would be wasted if the survey in question was not utilised.

Meanwhile, however, some of these grants had already been surveyed in anticipation of orders, but it was now, early in March, too late in the season to complete the survey of the remainder. In his letter No. 712, dated 14th October 1895, the Director of the Department of Land Records requests that the survey of this area of 14 square miles of lands under lease for 30 years may be left to the Settlement Department to complete.

277. The average size of the *jote* is 153·6 acres, and the average size of the field, calculated on the entire area surveyed, including the 30-year lease lands, is 1·23 acres.

278. The detail survey was checked by 833 linear miles of check survey (*partal*), 632 miles being by European and independent *partal* and 201 miles by native inspectors, thus giving an average per square mile of 2·9 for the former and 1 for the latter. Two sheets did not pass the test of independent *partal* and had to be resurveyed.

279. Eighty-seven boundary disputes were registered during the season, of which 79 have been disposed of and 8 are still pending with the Assistant Settlement Officer. Traces of the disputes were submitted to the Assistant Settlement Officer in duplicate, one copy being returned by him to the Survey Office with his decision recorded thereon. The boundary, according to the revenue survey, was invariably shown on these traces.

280. The Director, Bengal Surveys, visited the camp on the 16th December 1894, and inspected the field and office work in company with Captain Hodgson and Mr. Morshead, the Sub-divisional Officer of Kurseong. He again visited the camp on the 30th January 1895, and inspected the work in the field.

His Honour the Lieutenant-Governor inspected the records of a few *jotes* at Siliguri on 16th March 1895, and noticed some irregularities in the *khatians*. These were corrected at once. The *khatians* inspected by His Honour were the first few that had been written up, the work having just commenced and Mr. McHatton writes that steps were taken to prevent a recurrence of such mistakes.

The number of *khasra* entries checked by the European officers of the Survey Department is 1,574 and by native inspectors 16,460. The number checked by the Assistant Settlement Officer is 829. The total number checked by officers of the Survey and Settlement Departments is 18,863, which gives a percentage of 19 on the total entries.

281. As usual, the greatest difficulty was experienced in insisting on the distribution of *parchas* during progress of record-writing. Three *amins* were dismissed early in the season for withholding *parchas* till the work was finished, and this had a good effect to some extent on the others. In order to counteract the effect of this rascality on the part of the *amins*, it was notified by beat of drum at all the principal bazars that *parchas* were given to the *raiyats* free of cost; and that the object was to enable each *raiyat* to satisfy himself that his fields were being properly recorded by the *amin*. This had the desired effect. The people were roused to appreciate the value of their *parchas* which hencefforth they demanded as a right.

The total number of *raiyats*, including *jotedars*, *thikadars*, and *adhiars*, is 11,724, and the total number of holdings is 13,566. The average size of the holding is 9·2 acres.

282. The cost has been ₹39,852; the rate per square mile for cadastral survey is ₹150·3 and for records ₹39·4.

SURVEY OF THE PALAMAU GOVERNMENT ESTATE, CHOTA NAGPUR.

283. The survey of this estate was carried on during the season under report in continuation of the work of the two former seasons. The estimated area was about 273,635 acres, of which 70,400 acres was said to be under cultivation. The result of the present season's work shows that the cultivated area at present is about 100,000 acres. The area of the 397 *khalsa* villages circumscribed by the present traverse survey is 286·82 square miles, but this does not represent the whole area of the estate, as the traverse lines were taken round the cultivated portions of the villages only. Nor does it represent the cultivated area; for where the cultivation was much scattered in small patches, as it was in some parts, necessarily a large amount of jungle lands were included within the traverse circuits, as it was impossible to traverse each little isolated bit of cultivation separately.

Personnel.

Mr. L. F. Berkeley, Extra Assistant Superintendent, 6th grade, in charge.
2 head inspectors.
6 inspectors.
11 draftsmen, computers, etc.
57 *amins*.

284. The only traversing done this season has been that of one village, approximate area 4·57 square miles, lately resumed by Government, the remainder of the estate having been traversed in previous seasons.

285. Cadastral operations were commenced on the 1st November 1894. The survey this season was in operation chiefly in broad valleys separated by high ranges of hills. Both hills and valleys are thickly wooded, and the latter are undulating and intersected with ravines; consequently the cadastral survey has been carried on under very unfavourable conditions, particularly as the cultivation was to a great extent scattered about in isolated patches with thick tree and grass jungle intervening. These valleys are very unhealthy during and after the rains, and continue so till towards the end of January.

286. The following is the outturn of survey and record-writing for the season:—181 villages with 66,352 fields having an area of 161·75 square miles. The detail survey is mapped on 273 sheets. The average size of the field for the season is 0·82 of an acre, and for the entire estate, excluding jungle, 0·57 of an acre.

287. The test lines amount to 2·38 linear miles in every square mile of survey, and the number of entries checked in the records in 37 per cent. of the whole.

Captain Hodgson inspected the survey during April in the field, and reports that it is very accurate considering the undulating nature of the country, and that in the area he visited the country was extremely difficult to survey on so large a scale.

288. There were 68 boundary disputes brought to light during the season, of which Mr. Berkeley himself disposed of two and the Settlement Officer of the rest. In all cases the decision has been given in accordance with the revenue survey maps 1863-64, as the maps of the last settlement are said not to be very reliable.

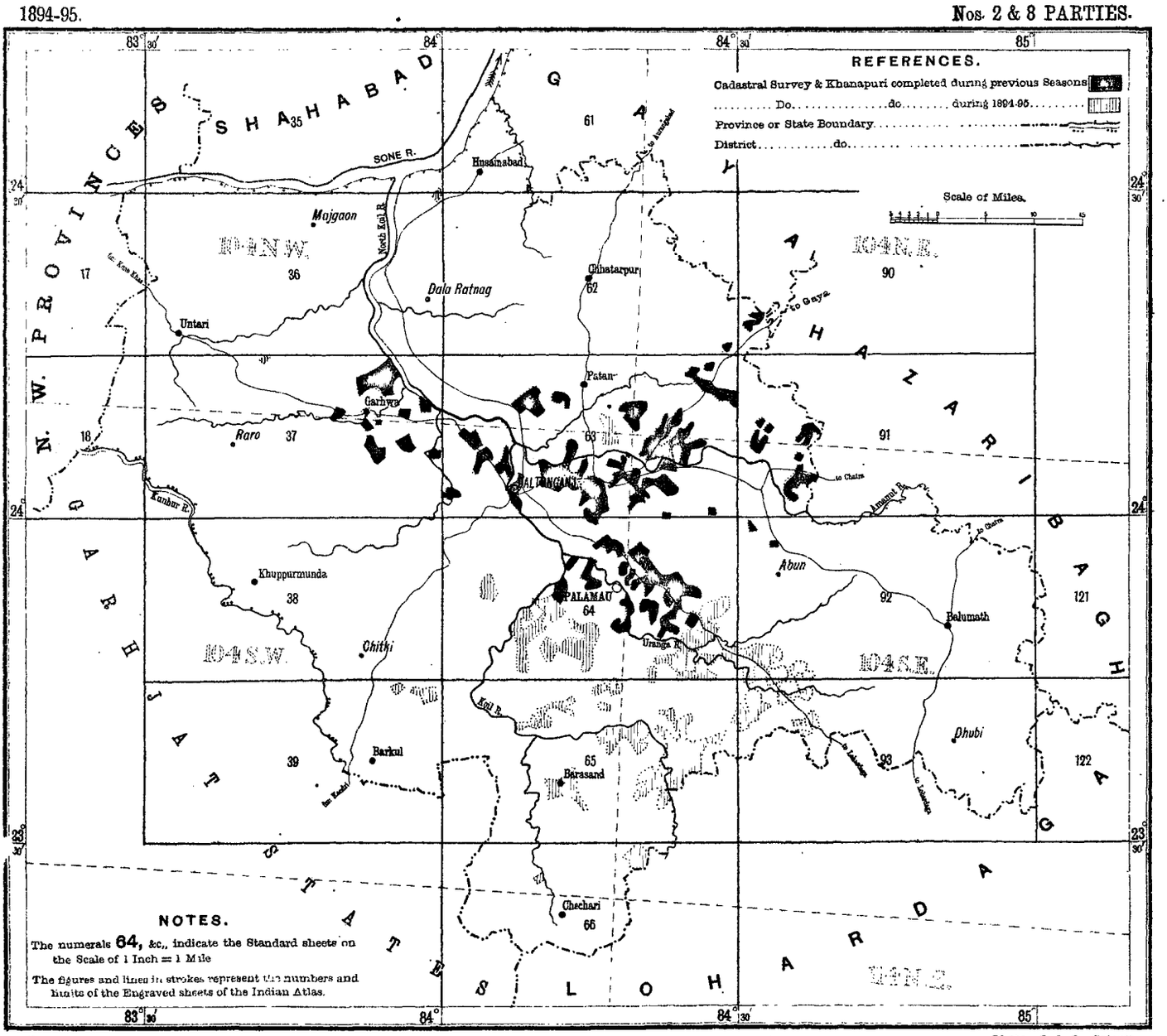
289. At the time of the last settlement masonry platforms were erected at the tri-junctions of the village boundaries, and in a few cases they were not placed on the correct spot as indicated on the revenue survey maps. This has chiefly occurred in places that were covered with jungle or were waste at the time the platforms were built. In each case a dispute has arisen which has been decided by the Settlement Officer in accordance with the revenue survey maps.

290. The field season closed on the 31st May, but three villages close to Palamau itself, the recess quarters of the section, were not completed till the 18th June owing to the refractory behaviour of the tenure-holders.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF KHALSA VILLAGES IN DISTRICT PALAMAU.

1894-95. Nos. 2 & 8 PARTIES.



Reg. No. 386, S. I. D.—Nov. 95.—1,050.

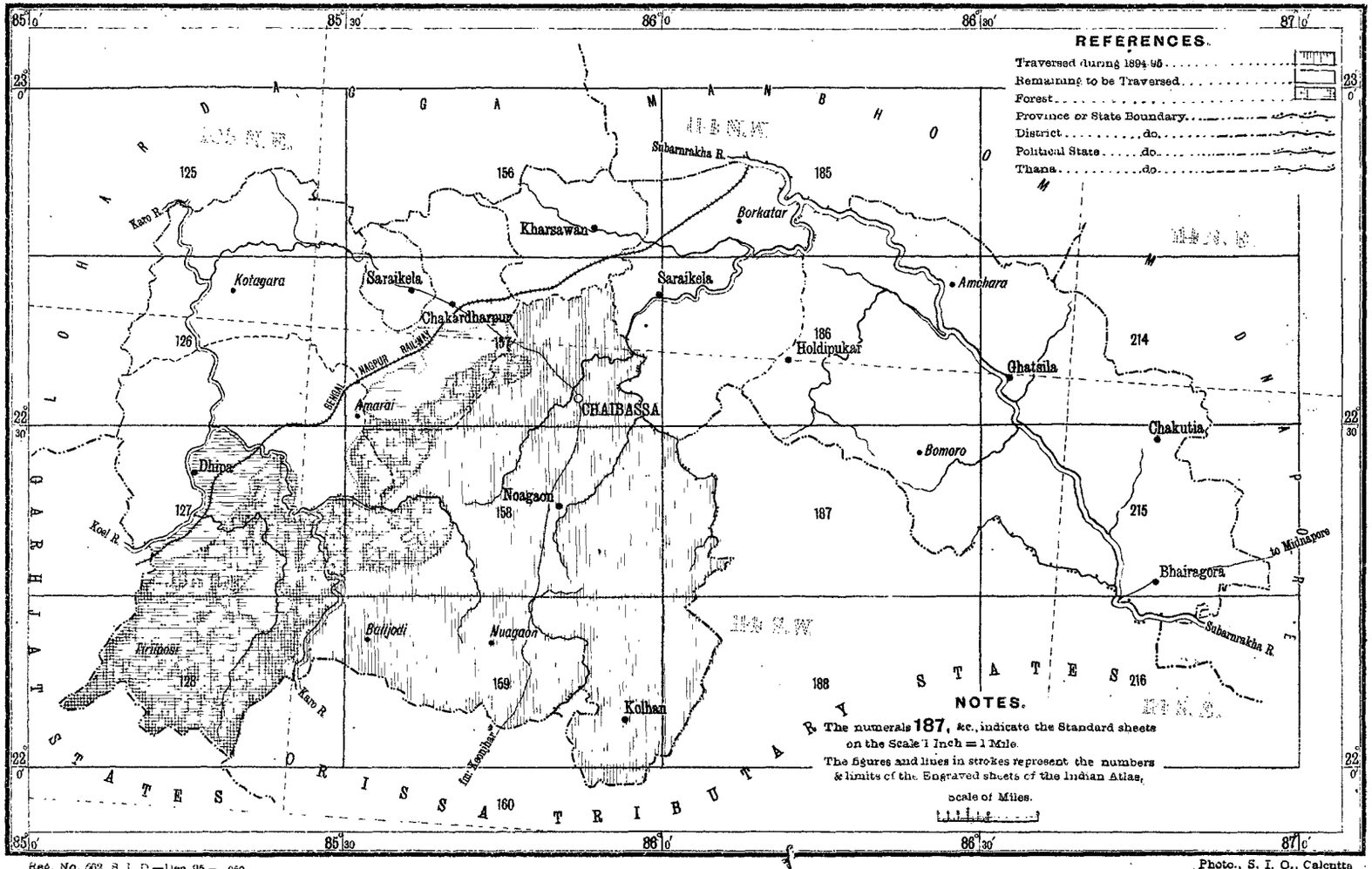
Photo., S. I. O., Calcutta.

No. 527-S. 95.

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY, KOLHAN GOVT. ESTATE, DISTRICT SINGBHUM.

1894-95. Nos. 4 & 5 PARTIES.



Reg. No. 562, S. I. D.—Dec 95—1,050

Photo., S. I. O., Calcutta

No. 554-S. 95.

291. The cadastral survey of the cultivated portions of the entire estate has now been completed; the total number of villages according to the present survey is 397, in which there are 160,903 *khasra* numbers, including the *jagirdars'* shares and jungle blocks enclosed within the traverse lines. Of the 397 villages at present composing the estate in only 215 cases has the entire village been surveyed. Of the rest only the cultivated portions have been surveyed, the blocks of jungle that are unavoidably included within the cultivated portions having been left blank on the maps, although each has received a number and is entered in the *khasra*.

TRAVERSE SURVEY OF THE KOLHAN GOVERNMENT ESTATE, CHOTA NAGPUR.

292. The Kolhan Government estate contains an area of about 1,423 square miles, exclusive of the forest reserves. The block marked as the Kolhan on the $\frac{1}{4}$-inch maps was found to comprise an area of about 1,170 square miles, the remaining 253 square miles being in Saranda, which, as also three villages to the north, have been included in the Kolhan since the maps were published.

Personnel.

Mr. G. G. Vander Beek, Extra Assistant Superintendent, 5th grade, in charge.
„ P. K. Vaughan, Sub-Assistant Superintendent, 3rd grade, from 29th November 1894.
17 computers, etc.
22 sub-surveyors.

293. The demarcation was done by the headmen of the villages (Mankis and Mundas) under orders issued by the Deputy Commissioner. In most cases thin reeds and branches of trees were put up without any earth and were erected in the middle of straight portions instead of at the bends and turns of the boundary; this made it difficult for the line-cutters to fix the traverse stations without local enquiries so as to keep within the offset limit.

294. The area traversed during the season was 1,175 square miles. The field work commenced between the 2nd and 5th November and closed on 30th April, when the camp started for recess quarters at Mussoorie.

295. The total of the linear miles of new chaining is 4,033 miles. The theodolite was set up at 26,456 stations, or, excluding starting and closing stations, 21,340 new stations were observed at.

296. Connections were made to 15 stations and intersected points of the Ganjam topographical survey of season 1856-57.

297. Of the 21,340 new stations at which angles were observed, 20,129 have been permanently marked, 1,211 being temporarily marked by pegs owing to disputes. Sub-traverse lines were run at a distance of 30 chains apart in open ground and also round blocks of cultivation and forest in villages where there is jungle separating the two, to facilitate the cadastral survey.

298. Plots of 221 villages covering 230 square miles on the 16-inch scale were made over to the Settlement Officer for cadastral survey between the months of February and April. The area remaining for traverse to complete the Kolhan consists of about 250 square miles including the villages inside of the forest reserve. The cost has been been ₹ 35,954 and the rate ₹ 30·6 per square mile.

299. The orders for taking up the survey were received rather late; men transferred from other parties had to be called and new men entertained to make up the necessary establishment for the work; also the procuring of equipment delayed the line clearing squads from starting in advance of the traverse. The country being for the most part hilly and covered with jungle, and the majority of the line-cutters being new to the work, there were delays in line-clearing. The sub-surveyors having to take angles of elevation and depression with the clinometer owing to the undulations and hills also retarded the work. The Kol *khalásis* were found to be lazy and never ready for work in time, and on any friction occurring between the surveyors and themselves they deserted, even though due a month's pay. This necessitated a continual change in the squads, and new men had to be entertained, which delayed the work of the surveyors.

300. The sub-surveyors were frequently inspected in the field by both Messrs. Vander Beek and Vaughan,—in fact Mr. Vaughan was kept nearly the whole season on inspection work.

SURVEY OF THE GOVERNMENT ESTATES, GAYA DISTRICT.

301. The survey of the Government estates in the Gaya district was notified in the *Calcutta Gazette* of the 10th October 1894, and regazetted in notification No. 4029 L.R. on the 28th August 1895.

Personnel.

Mr. G. T. Hall, Extra Assistant Superintendent, 5th grade, in charge.
1 head inspector.
10 inspectors.
47 *amins.*

302. The traverse survey was carried out by a detachment of Nos. 4 and 5 Parties.

303. The particulars of the cadastral survey on the 16-inch scale, including the record-writing, are shown in the following statement:—

District.	Number of villages.	Number of fields.	Area in square miles.
Gaya (Government estates)	108	62,785	88·89

In addition to the above one village was surveyed on the 32-inch scale, being the revision of a former survey. The area was 0·61 square mile.

304. In every village where there was an appreciable difference between the present boundary and that as shown in the old revenue survey, it was treated as a dispute, although in reality none existed, and, as the Collector wished all differences to be surveyed, it laid a heavy task on the inspector and increased the office work. A duplicate of every difference sent to the settlement had to be forwarded to the Collector. There were in all 132 disputes.

305. The average size of the field is 0·90 of an acre.

306. The cost has been ₹15,757; the rate for survey ₹109·2 and for record-writing ₹67·7 per square mile.

SURVEY OF THE TIKARI ESTATES, GAYA AND PATNA DISTRICTS.

307. The traverse survey of these estates was continued by a detachment of Nos. 4 and 5 Parties, the cadastral operations only being done by Nos. 2 and 8 Parties. The work was under the supervision of Mr. G. T. Hall, with the same establishment as was employed on the survey of the Government estates in the Gaya district.

308. The particulars of the cadastral survey are shown in the following statement:—

District.	Cadastral Survey, 16 inches=1 mile.			Record-writing.			Skeleton boundary survey.	
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Area in square miles.
Gaya . . .	30	8,915	10·86	87	61,729	58·49	40	20
Patna . . .	8	10,173	5·51	8	10,173	5·52	...	...
Totals .	38	19,088	16·37	95	71,902	64·01	40	20

The survey in Gaya is mapped on 29 sheets and in Patna on 10.

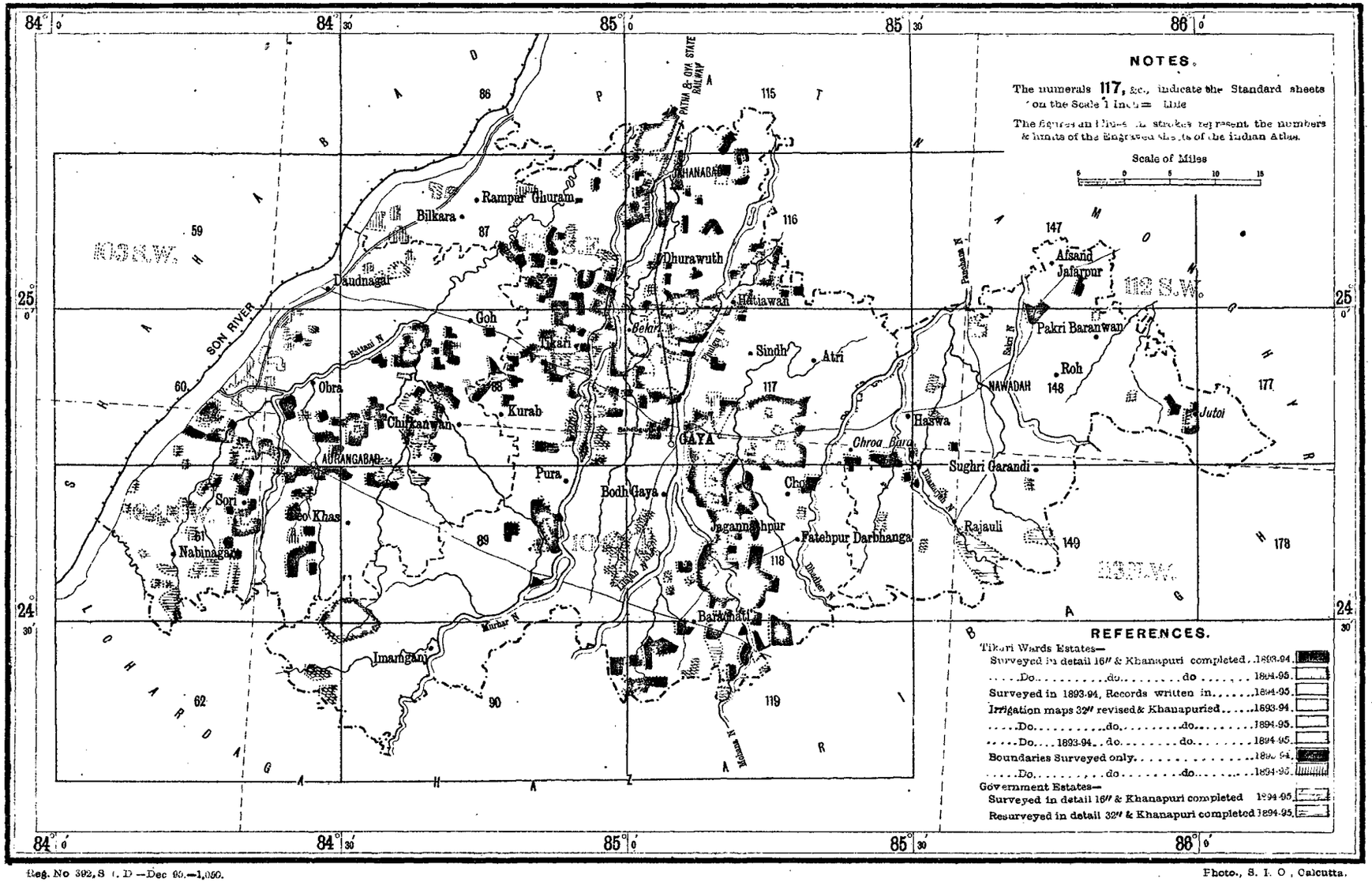
309. As there had been a previous cadastral survey of certain irrigated villages on the 32-inch scale, the maps of this survey were revised. The following is the outturn:—

District.	Revision Survey, 32 inches=1 mile.			Record-writing.			Skeleton boundary survey.	
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Area in square miles.
Gaya . . .	7	1,922	1·72	9	6,956	5·26	2	3

BENGAL SURVEY

INDEX TO THE CADASTRAL SURVEY IN THE TIKARI & GOVT. ESTATES IN DIST. GAYA.

1894-95. Nos. 2 & 3 PARTIES.



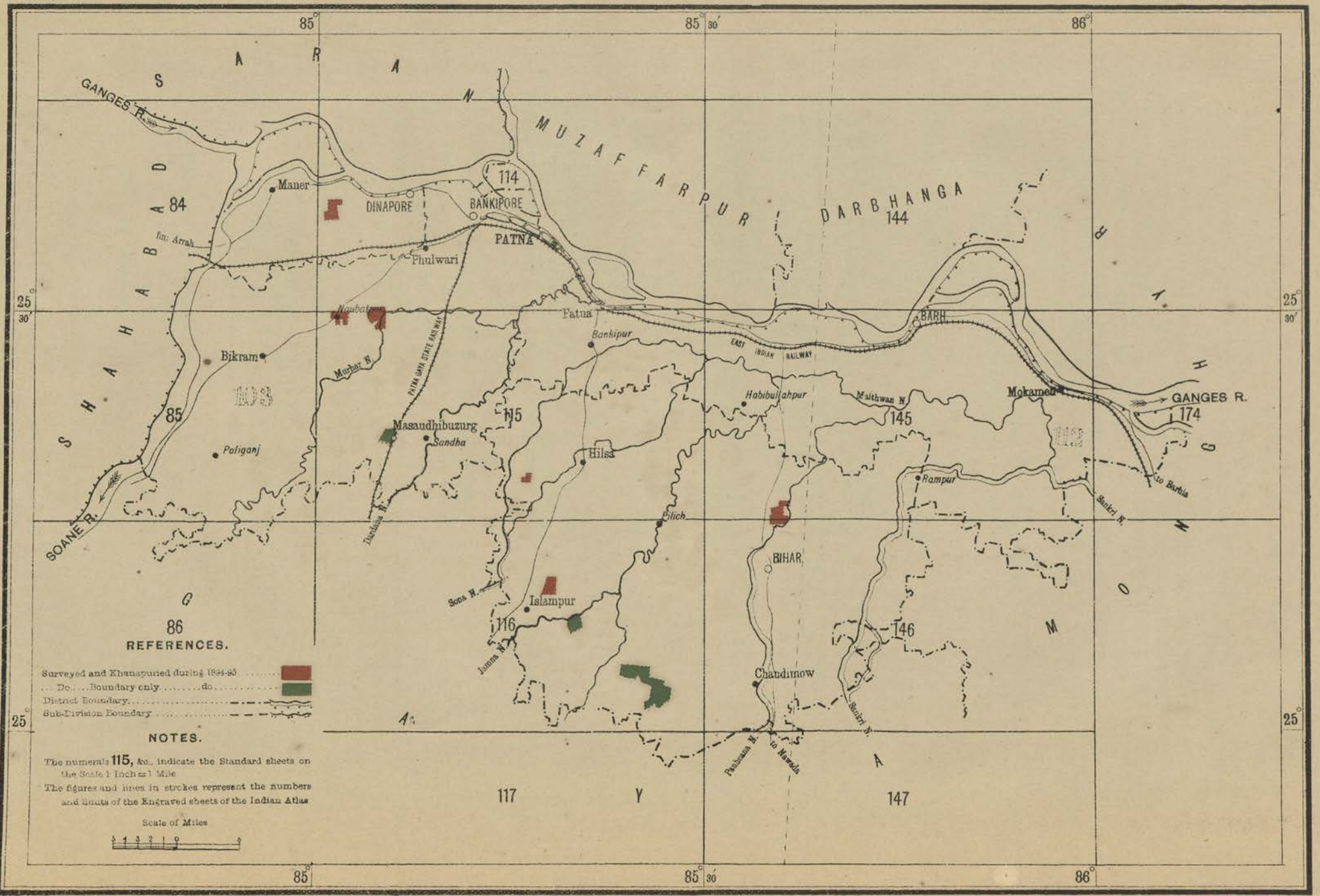
Reg. No 392, S. I. D.—Dec 95.—1,050.

Photo., S. I. O., Calcutta.

No. 555-S. 95.

BENGAL SURVEY.

1894-95. **INDEX TO THE CADASTRAL SURVEY OF THE TIKARI ESTATE IN DIST. PATNA.** Nos. 2 & 8 PARTIES.



Reg. No. 891, S. I. D.—Nov. 95.—1,050

No. 528-S. 95.

Photo., S. I. O. Calcutta.

This revision survey is mapped on 11 sheets. The average size of the field is 0·69 acres.

310. In the Gaya district the check surveys aggregate 787 linear miles, of which 289 linear miles were run by the Assistants or independently after the maps had been lodged in office, and 498 linear miles were run by inspectors. The incidence of the whole is 3·22 linear miles per square mile of survey. The number of entries in the *khasras* which were checked amounts to 42,220.

311. The number of boundary disputes, forwarded to the Settlement Officer, is 86 in the Tikari Ward's estate. On the 20th of August there were 7 remaining for decision. Of last year's disputes, of which 130 were left over for this season, all have been decided. The maps have been corrected; but as the field establishment has been withdrawn, the demarcation of some of the villages could not be carried out. The Assistant Settlement Officer has had a list of villages sent him in which the demarcation has not been done.

312. The cost of the cadastral survey has been ₹9,931 and of record-writing ₹15,054. No rates can be given, as this cost is for the completion of arrears as well as for a very small area of new work.

313. Difficulty was experienced in obtaining definite information regarding several villages, the names of which appeared in the lists received from the Assistant Manager of the estate. Two lists containing 139 and 66 villages respectively, were received on the 16th November 1894. The list of 66 villages was submitted as that of those villages which had been surveyed last season, although their names could not be traced in the Raj registers; but after a re-comparison of lists and frequent references to the office at Gaya the *muharrir*, who was deputed by the estate for the comparison, admitted that all the villages of last season's survey were in possession of the Raj. These difficulties show how much the survey was required.

314. During the past season, by the orders of Government, an attempt was made to use the *patwâri* as a *muharrir*, but Captain Hodgson reports that his introduction as a *parcha muharrir* did not prove satisfactory. He appears to be everybody's servant, and yet under no one's direct control. He was always putting forward his duties in connection with assessment of revenue as an excuse for his erratic attendance; and as the Camp Officer had no means at his disposal, whereby he could compel the *patwâri* to put aside his assessment duties, his erratic attendance proved a hindrance to the work rather than a help. Mr. Hall was constantly reporting to the Collector, Manager, Assistant Manager, and Circle Officers, and although his reports, in some cases, had the desired effect, the *patwâris* were often too late to prove of any benefit to the record-writing. This arrangement was scarcely fair to the *amin*, for the *amin* had to engage a *muharrir* when the *patwâri* was absent, and when it pleased the *patwâri* to return the *muharrir* was deprived of his duties.

315. In many villages cylinders or demarcation marks had been removed, and in a few instances four or five from a single village, and there is but little doubt that this action on the part of the *zamindars* and others is, in a great measure, due to the false idea they labour under that possession is affected by these theodolite marks.

316. With the exception of a small area, the physical features of the country presented no special difficulties. In the villages adjacent to or near the Hazaribagh frontier the country is very hilly and covered with dense forest; and as the population is scattered and sparse, difficulty was experienced in procuring labour for line clearing, and the progress of the work in that portion was naturally slow and unsatisfactory.

317. On the 23rd of January 1895 orders were received that the Municipality of Tikari had applied for a large scale survey of the town, and that arrangements were to be made accordingly. As this town had been partially traversed last season, the surveyor was told to utilise the old stations, the angles and distances were given the surveyor, and the present stations correspond with those observed last year. The number of stations fixed, including sub-traverses, is 139, and locally-manufactured cylinders have been embedded.

318. The area estimated by the Municipality was 541 acres. The result of the survey has proved the area to be 540·69 acres. The survey has been completed on 11 sheets and on a scale of 64 inches=1 mile.

319. The Manager of the Tikari Ward's estate has requested that a copy of the map and *khasra* be prepared for the Raj. This is being done, and the trace and records will be handed over soon.

320. The survey and preparation of the record and additional map for the Municipality has been estimated to cost R890. As the Municipality have now asked for two wall maps on the 32-inch scale, these will be put in hand, but it will be some months before they receive them, for the pentagraphing of the numerous minute details will be a laborious undertaking, necessitating considerable care. The above sum will probably be sufficient to cover the cost.

Survey of the Chaurasi Estates, District 24-Parganas.

321. The traverse and cadastral survey of these estates was continued. One head inspector with one inspector and 25 *amins* was employed on the work, which was inspected from time to time by Messrs. P. A. Peters and P. C. H. Smart, and Babu Sarat Chunder Sen, whose reports on the progress and quality of the survey were satisfactory.

322. Only one *mauza*, which had not been previously pointed out by the proprietors, was traversed during the year. It has an area of 183 acres and required the observation of 9 angles only.

323. On the 4th December 1894, the cadastral establishment left Calcutta, and survey work was started generally on the 8th December.

324. There were 15 boundary disputes which the Settlement Officer decided during the field season.

325. The boundaries of *mauzas*, according to the old revenue survey maps, were shown on the cadastral maps after measurement was completed and before *khanapuri* was started.

326. Owing to the great number of disputes, progress in record-writing was miserably slow. At first 2,424 entries out of 2,772 were disputed, that is, about 88 per cent. of the total number of *khasra* entries. The *amins* had first to record the disputes in the dispute list. The Settlement Officer, in the course of his inspections, used to decide the disputes, and the *amins* had then to make the entries again in the *khasras*. The ground was thus gone over twice.

The disputes were principally between the *zamindars* and tenants. The majority of the disputes were owing to the following causes:—

(*a*) In cultivation the *zamindars* denied the existence of any intermediate tenures.

(*b*) The *zamindars* claimed all waste, tanks, etc., as their *khas*, even though these were in the possession of *raiyats*.

(*c*) The *zamindars* disputed all claims to rent-free lands.

The disputes eventually decreased, as the Settlement Officer's decisions in the first villages became known. The total number of entries disputed was 9,926, or nearly 16 per cent. of the whole *khasra* entries.

327. The *raiyats* showed great disinclination to accept their *parchas*, notwithstanding the Settlement Officer's explanations on the subject. Of a total of 16,817 *parchas*, only 10,679 were taken by *raiyats*, leaving 6,138 undistributed. These will be made over to the Settlement Officer with the completed records.

The outturn of cadastral survey and record-writing for the season is given below:—

District.	Cadastral Survey and Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.
24-Parganas	53	62,129	33·27

The average size of the field is 0·35 acres.

328. The total cost of operations has been R5,975, which gives an incidence of R108 per square mile for survey and R78·1 for record-writing.

329. There was no continuous European supervision in the field, but the *amins* were inspected during five months of the field season by Messrs. Peters, Smart, and Sen, who at the same time tested the work in progress. The total of tests applied is 65 linear miles, which gives an average of 2 linear miles per square mile. A total of 12·306 *khasra* entries, or 20 per cent. of the whole number, were checked by the Sub-Assistant Superintendents, head inspector, and inspector. The Settlement Officer was constantly with the *amins*, and Mr. Shaw says he checked a large percentage of the *khasra* entries, and he is responsible for its accuracy according to the rules under which the work is carried on.

SURVEY OF THE TANTIBUNIA ESTATE, DISTRICT KHULNA.

330. The survey of this estate had been previously notified in the *Calcutta Gazette* of 28th February 1894.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 6th grade, in charge.
1 inspector.
2 sub-surveyors.
13 *amins*.

331. The Tantibunia estate is known as lot 239, or *tauzi* No. 848 of district Khulna, and is situated in the northern part of the Sundarban portion of the district. It has hitherto been wrongly described as *Tantabaria*. It has an area of 20 square miles and is in one compact block and is entirely surrounded by tidal streams. It is touched on the north by the parallel of 22° 30′ north latitude, and on the east by meridian 89° 45′ east of Greenwich.

332. At the previous revenue survey no divisions of this estate existed, but the proprietors have now divided it into eight parts which they call *mauzas*. The exterior limits of these *mauzas* have been traversed. The internal traverses within these *mauzas* have followed the limits of the principal tenures, of which there are 43 in the whole estate.

A main traverse has been taken round the exterior limits of the estate. The angular observations have been checked by ten azimuths taken to the sun. There were no G. T. survey stations in the vicinity with which connection of the traverses could be made, so that geographically the exact position of the tract has not been determined.

333. All theodolite stations were marked by glazed pottery pipes from Messrs. Burn and Co. of Raniganj. The number of large permanent marks embedded at tri-junctions was 120 and of small 470 at other stations.

334. Owing to the high tides and consequent flooding of the country during part of March, April, and May progress was much retarded.

335. The outturn of traverse work has been 20 square miles. There were 590 angles observed, and the linear miles of chaining amounted to 82.

336. The cost of traverse survey has been Rs. 1,306, including cost of marking stations, and the rate Rs. 65·3.

337. Before cadastral operations started in January, the agents of the proprietors came to Calcutta to request that a field survey might be undertaken of only those portions of the estate which they held *khas* where they had direct dealings with the *raiyats*, and that for the remainder a survey of the external limits of tenures of first instance, would meet their requirements. This request was disallowed by the Director of Land Records, and the whole estate has been measured in the usual manner on the scale of 16 inches to the mile.

338. In a considerable portion of the cultivated area there are no ridges marking the boundaries, and the attendance of cultivators during the measurement work was therefore absolutely necessary. The southern portion of the estate is cultivated by non-resident *raiyats*, who live at some distance from the spot, and the assistance of the Collector had to be asked to enforce the attendance of these men. The Deputy Collector, acting as Settlement Officer, arrived at the estate early in June, and the steps he took to make cultivators attend were so effective that complaints of non-attendance were thereafter very few.

339. Record-writing was carried out entirely under the supervision of the Settlement Officer, who settled disputes as they arose, so that on completion of the work no disputes existed.

340. The outturn of cadastral survey and record-writing during the season under report is shown in the following statement:—

District.	Cadastral Survey and Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.
Khulna	8	4,376	20

The average size of the field is 2·92 acres. In the 4,376 numbers there are 1,237 tenancies.

341. The check surveys of all kinds are 42 linear miles, which gives an incidence of 2·1 linear miles per square mile, or 5 miles per *mauza*. Besides attending on the Settlement Officer during the settlement of disputes, and having correct entries made in the *khasras*, the head inspector checked 430 entries, or 10 per cent. of the total number.

342. The cost of cadastral survey, including record-writing, has been Rs. 2,843, and the rate per square mile for survey Rs. 107·2 and for records Rs. 38·7. *

YAMETHIN, SHWEBO, KATHA, ETC., DISTRICTS, UPPER BURMA.

No. 3 Party.

343. Mr. G. B. Scott was in charge of this party at the commencement of the year under report, but in December 1894 he was appointed to be Superintendent of Land Records Surveys in the North-Western Provinces, and was replaced by Mr. G. H. Cooke.

Personnel.

Mr. G. H. Cooke, Superintendent, 2nd grade, in charge from 12th December 1894.
„ G. B. Scott, Deputy Superintendent, 1st grade, in charge up to 12th December 1894.
„ J. Connor, Extra Assistant Superintendent, 4th grade.
„ G. C. Swiney, Extra Assistant Superintendent, 5th grade, from 1st January 1895.
„ C. W. Wilson, Extra Assistant Superintendent, 5th grade.
„ O. D. Smart, Sub-Assistant Superintendent, 1st grade, up to 21st December 1894.
„ P. J. Serrao, Sub-Assistant Superintendent, 2nd grade.
„ F. P. Walsh, ditto, 2nd grade.
„ W. J. Baker, ditto, 2nd grade.
„ H. B. Powell, ditto, 3rd grade.
„ O. C. Ollenbach, ditto, 3rd grade.
„ W. Newland, ditto, 3rd grade.
36 surveyors, sub-surveyors and others.
10 inspectors (temporary).
100 field surveyors (Indians).
20 ditto (Burmans).
42 holding markers and record-writers (Burmans).

344. The programme as laid down for 1894-95 was strictly carried out, and the operations of the party were extended over a large and scattered area.

345. The work of the season comprised:—

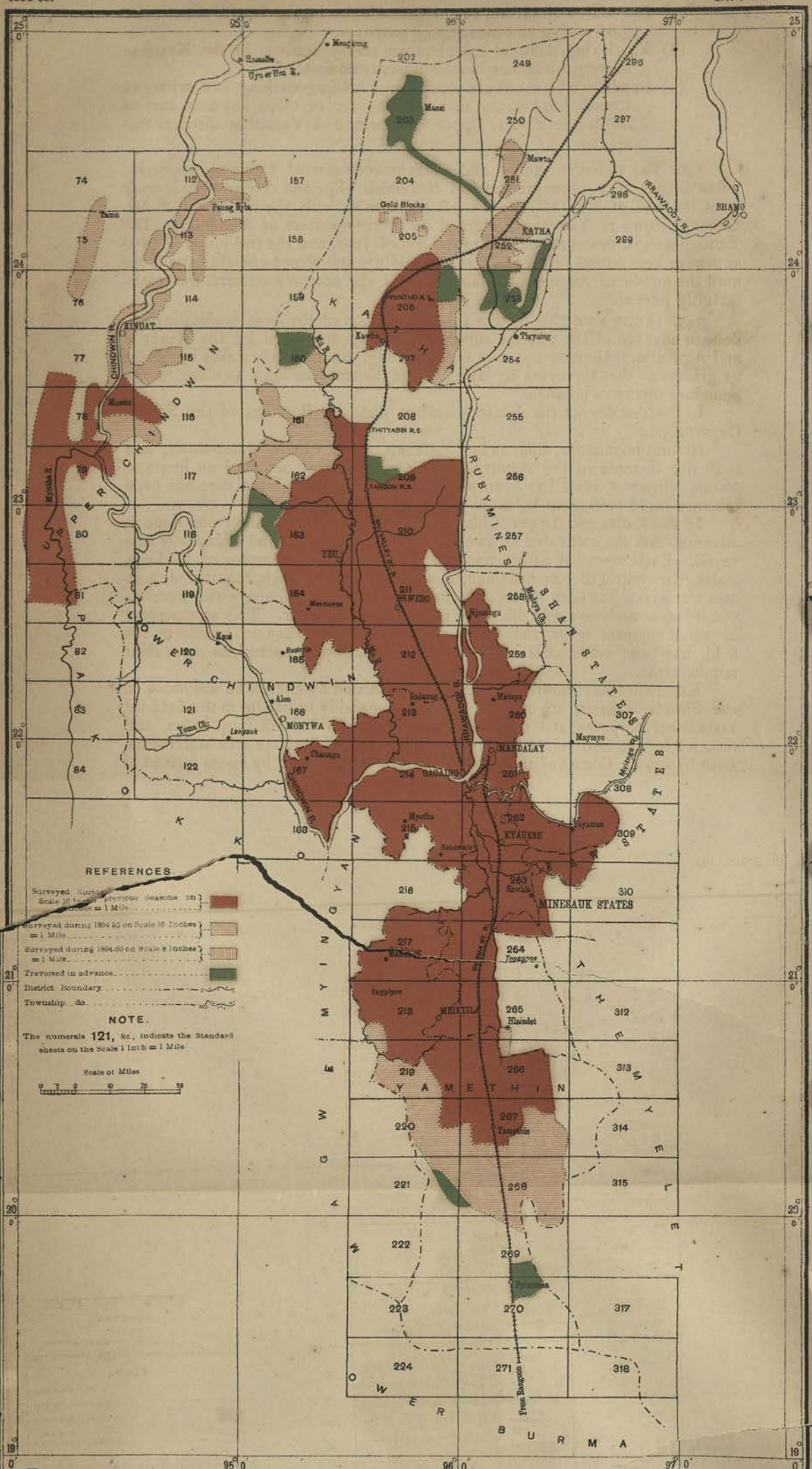
(1) The continuation and completion of the cadastral survey of the small area of 95 square miles of the Meiktila district.
(2) The traverse and cadastral survey of over 1,000 square miles of the Yamethin district.
(3) The advance traverse survey of a small area of the Pyinmana district, now constituted a sub-division of the Yamethin district.
(4) The extension of the traverse and cadastral survey of the cultivated area of the Katha district.
(5) The continuation of the traverse and cadastral survey of the Shwebo district, including the Yeu district, which has lately been made into a sub-division.
(6) The continuation of the traverse and cadastral survey of the cultivated portions of the Upper Chindwin district, on either side of the Chindwin river, and the completion of the Kale and a portion of the Kubo valley.

* Captain Hodgson reports that all the assistants both European and Native, rendered good service Mr. McHatton is mentioned as having been conspicuously successful.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS SAGAING, SHWEBO, YAMETHIN, YEU KATHA, MANDALAY, MEIKTILA, KYAUKSE & UPPER CHINDWIN.

1894-95. No. 3 PARTY.



No. 336-S. 96.

(7) The survey of certain square mile blocks in the Katha district for gold mining and prospecting purposes.

(8) The laying down of cylinders on survey stations in the Kyaukse district, which has now been nearly completed.

(9) In addition to the above operations, holding-marking and writing of record-of-rights, and making a register of crops, has been carried on in the Katha, Upper Chindwin, and Yamethin districts this season.

346. The different camps and detachments started for their respective fields of operation about the end of November 1894 and continued field work until the end of May 1895, when all the camps, with the exception of Mr. Connor's camp in Yamethin, returned to recess quarters at Mandalay. The Yamethin work was continued up to the end of June, and the two junior Assistants were kept out to *partal* and test the holding, and record-of-rights and crops until the middle of August, by which date all the season's outturn was satisfactorily passed.

347. In the Yamethin district the demarcation of the *kwin* boundaries was done in advance of the traverse survey by officers appointed by the Revenue and Agricultural Department, who supplied rough traces of the *kwins* by circles as guides to the surveyors in laying down the traverse lines as close to the boundary marks as possible.

In the Yeu district the demarcation was done by Burmans of the Survey Department.

Natural boundaries, such as large streams, roads, canals, water-sheds, and such like features of the country, have invariably been adopted as limits to *kwins*, whenever such has been possible. In cultivated areas care has been taken to avoid cutting up holdings.

In the Katha and Upper Chindwin districts no demarcation was done in advance, and the cultivated areas only have been traversed and cadastrally surveyed. Each so-called village was composed of a certain number of holdings under the control of one headman, a separate map of which, together with an area statement, has been made. Each village has been given a serial number, and its area rarely exceeds the space of one sheet of paper. This arrangement of small compact maps, the traces of which will be easy to handle in the field, has been made after consultation with the local authorities as to their requirements.

Experience has shown that the traces submitted by circles, as was done in the Shwebo district, are far too large and unwieldy to handle in the field for assessment purposes, and these are now being divided off into *kwins*, and retraced for the Settlement Department with new and separate area statements, *kwin* by *kwin*. Copies of these maps will also be submitted by *kwins* instead of by circles to the Calcutta Office for reproduction.

348. The strength of the cadastral establishment from India consisted of 10 inspectors and 80 *amins* at the commencement of the season; this number was found to be quite insufficient to carry out the programme laid down for survey, and a number of Burman *amins* were therefore engaged, and drafts were obtained from No. 12 Party to bring up the strength of the cadastral hands to efficiently cope with the large area of nearly 1,800 square miles of 16-inch survey, scattered over six districts.

The traverse section was also found to be too weak and had to be strengthened.

The traverses were at once computed on receipt of field books in office, and plotted and given out for cadastral survey; the calls for plots were incessant, causing much anxiety lest the cadastral contract hands should be thrown out of work. In order to avoid similar inconvenience next season, an extra traverse camp will be formed to be employed on advance work only.

349. The holding-marking, record-of-rights, and registers of the nature of crops were undertaken in the districts of Katha, Upper Chindwin, and Yamethin, aggregating an area of over 1,000 square miles in the three districts. A considerable extra establishment of Burmans was entertained for this work, and some of the European Assistants have been employed in checking this holding-demarcation and record-writing on the ground, in addition to other duties.

In the Yamethin district this work was started for the first time in March last, after the Deputy Surveyor-General had inspected the party; since which the holding-marking and record-writing of 585 *kwins* of the last and present season's work in this district, covering an area of over 600 square miles, have been done. The system adopted was identical with that in force in the local settlement surveys.

Survey of the Yamethin district.

350. In this district advance traverse had been executed over about 350 square miles. Plots of 70 square miles were supplied by the local survey.

During the season about 580 square miles of additional traverse was done, the plots of which were prepared, giving a total area of 1,000 square miles, the whole of which was surveyed cadastrally during the season by Mr. Connor's camp. The tract surveyed was divided into 932 *kwins* and has been mapped on 1,515 sheets.

351. The detail survey in this district was tested by 977 linear miles of check survey run by European and native agency. The check lines were run independently of the field survey and recorded in field books and compared afterwards in office.

352. The country surveyed is highly cultivated along the line of railway and some miles on either side, which forms an open plain, entirely under rice cultivation, and is almost all irrigated. Beyond this plain, to the west, the country is undulating and has patches of upland cultivation, principally maize, millets, and gram, and is fairly well populated throughout.

353. The field by field survey on 1,600 sheets has been traced and area statements made for the Settlement Department. The record-writing and holding marking of 535 *kwins* of this season's work remain to be done; the tracings of these villages will, therefore, be submitted to the Settlement Department during the ensuing field season.

Survey of the Meiktila district.

354. An area of 95 square miles, which had been traversed during the previous season, was surveyed cadastrally on the 16-inch scale, in congregated village form, as no demarcation of *kwins* had been done at the time of survey. This area has been mapped on 95 sheets. Tracings from these congregated sheets have been made in duplicate: one copy for reproduction of each *kwin* map separately for the Calcutta Office, and one copy for submission to the Settlement Department. This want of demarcation of *kwin* boundaries at time of survey, both in Shwebo and Meiktila, has entailed much extra office work, as the tracings, field numbering, and area statements have all had to be redone after the *kwin* boundaries had been marked off on the congregated village maps by the Settlement Department.

355. No record-writing or holding-marking was undertaken in the Meiktila district by the Survey Department, as this branch of the work had been done by the local Settlement Department.

356. The country surveyed this season is rough and broken, and in some parts covered with small, low undulating hills with scrub jungle; it is poorly cultivated and has, comparatively speaking, few inhabitants.

357. Tracings of the 95 *kwins* surveyed during the season have been made for the Settlement Department, together with the area statements of the whole. The cadastral survey of the district on the 16-inch scale has been completed and brought to a close.

Survey of the Upper Chindwin district.

358. In order to test the triangulation on the Chindwin river, a series of triangles was run from the G. T. series on the Irrawaddy to the topographical series on the Chindwin river.

The value of Taunggyi H. S. from the G. T. series was found to be almost identical with Colonel Woodthorpe's value in longitude, but differed by about 5 seconds in latitude; this correction has been applied to the topographical triangulation, and the traverses have been connected with it.

There being no traverse work in this district in advance, and no time for the traverse surveyors to get ahead of the field surveyors, the system of working by quadrilaterals, without plotted points, was tried, but turned out a complete failure, and many of the sheets had to be rejected or redrawn. Traverse plots were then hurriedly issued to the cadastral surveyors before any more detail work was taken up.

359. Work was begun this year in the Kindat township, and on its completion the men were moved into the southern half of the Balet township. The 16-inch work was eventually carried up the Chindwin river as far as Paungbyin and as far north as Lat. 24° 23′. Two inspectors and their squads were employed in the Kubo valley, but one squad had to be withdrawn early in April owing to sickness and the early and extremely heavy rainfall which set in about the middle of that month. They were then employed on the survey round about Paungbyin. The men working in the Kubo suffered considerably from sickness, but managed, however, to finish the work there, before leaving for Mandalay.

360. In this district an area of 150 square miles was surveyed cadastrally on the 16-inch scale, comprising 210 villages, tracings of which have been made for the Settlement Department on 120 sheets, together with area statements and register-of-rights.

361. The traverses were run along the Chindwin river and the main streams leading up the lateral valleys where there was cultivation. Azimuths were observed to check the bearings and connections made wherever it was possible. The traverses were made to enclose the cultivated areas wherever the cultivation was broad and extensive by small circuits. One European assistant was employed throughout the season in checking the field by field survey as well as the holding and record-of-rights. Every sheet was tested before closing work. The usual amount of inspector's *partals* were also run and recorded in field books, in addition to the above, and the work was found to be good.

Survey of the Katha district.

362. In Katha the area laid down in the programme was 200 square miles, whereas it was found that the cultivated and cultivable State lands of this district remaining for survey are more than treble this amount and could not possibly be completed in one season as was expected.

A detachment was sent into the district about the beginning of December and started the traverse survey round about Indaw, working northward as far as Mawlu, and southward down the Meza valley as far as Tigyaing on the Irrawaddy.

363. The method adopted this year consisted in running traverses in circuits round the open tracts of rice cultivation in the neighbourhood of Indaw, and from these circuits starting other single lines of traverses along the valleys containing cultivated lands; such traverses were continued until a connection could be made, either on a Great Trigonometrical station, or on another set of traverse lines running along an adjacent valley, and thereby forming a circuit. This system answers admirably for country of this description.

As soon as the plots were ready two squads of *amins* were put in at the beginning of February, and turned out an area of 163 square miles of the cultivated lands by the middle of April, when the early rains set in heavily, flooding the valleys and making it quite impossible to carry on any further field work.

The detachment was recalled to recess quarters at the beginning of May, when it was prostrated by fever and ague. This district becomes most deadly as soon as the early rains set in, although it is fairly healthy in the dry season.

364. The demarcation of holdings and the writing of records of tenants and crops were done this season as before by Burman *amins*. As no demarcation had been effected in this district, and only the cultivated and cultivable lands were surveyed on the 16-inch scale, it was necessary to form villages during the progress of the survey, which was done by grouping the holdings under the jurisdiction of one headman, and calling the group a village. A tracing of every such group was made and was accompanied by an area statement, all of which have been submitted to the Settlement Department for record.

This system was adopted, after consultation with the district authorities as to their requirements. Separate tracings of these groups of holdings have also

been made for the Calcutta Office for reproduction, instead of submitting the original field sheets, which have been plotted and surveyed in congregated form, as the holdings were not known at the time of the traverse survey, and not marked until the 16-inch survey was completed. The cultivated area of this district, aggregating 163 square miles, has been mapped on 210 sheets and checked by 94 linear miles of *partal* by European and Native agency. A certain percentage of holding-markings and record-of-rights of tenants have also been tested by European agency.

365. Connections were made in this district on four triangulation stations of the Mandalay Meridional series with satisfactory results.

Survey of Yeu and Shwebo districts.

366. The area supposed to be remaining for survey on the 16-inch scale in Yeu and Shwebo was put down on the programme as 250 square miles, but it was found that there was more than double that area of State lands cultivable or under cultivation and fit for a 16-inch survey. Arrangements had, however, been made for the survey of the above area only, which was accomplished by the end of May. It was then too late to add to the strength of this camp even if the men had been available, which they were not, so the excess area must be taken up next year.

367. The portion of country embraced by the traverse and cadastral survey this season lies to the west of the Mu river and contiguous to the previous season's work, extending up the valleys as far as the range of hills on the boundary of the Upper Chindwin district to the west. The streams rising in this range of hills, which is the watershed between the Mu and Chindwin rivers, flow on the Shwebo side in a south-easterly direction through the low and undulating lands, forming at first narrow cultivated valleys, but gradually broadening out into extensive rice lands on either side. They join the main stream in the Mu valley.

368. In the Yeu district an area of about 240 square miles of 16-inch scale survey has been completed this season, which has been mapped on 238 sheets, tracings of which have been made for the Settlement Department. The maps have been tested by 52 linear miles of *partal*.

The Settlement Department has undertaken the record-of-rights and holding-marking, the Survey Department furnishing the area statements only.

369. In the Shwebo district an area of about 150 square miles fit for a 16-inch survey still remains for next year; it consists of patches of cultivation surrounded by low hills covered with dense jungle, with scattered villages on the banks of the streams in the lowlying valleys, which are subject to inundation during the rains. This portion of country is situated to the north of the Shwebo district between the Irrawaddy and Mu rivers, and touching on the Wuntho township of the Katha district, on either side of the Mu Valley Railway line.

Survey of gold mining blocks in Katha district.

370. Numerous applications having been received through the Deputy Commissioner of Katha for the survey of gold mining grants in that district, Mr. Powell, Sub-Assistant Superintendent, and a Native surveyor, with their squads, were told off for this work. About 5 square miles of country were traversed and mapped on the 8-inch scale, 3 square miles of which have been contoured, traced, and submitted to the Deputy Commissioner, and two square miles still remain to be finished.

371. The country in which these blocks are situated is extremely difficult, notoriously unhealthy, very wild and mountainous, and covered with dense jungle.

The labour of making a survey of such country on the 8-inch scale is therefore very great. The survey of the gold mining blocks was continued until March, when both Mr. Powell and the Native surveyor and a number of the men were completely prostrated with fever, and had to be withdrawn from the work in a critical state of health.

372. Although the applicants for gold mining grants have been very numerous, and surveys of 10 or 12 square-mile blocks, scattered over a considerable

area of country, have been made, only one company has attempted to work its grant, *viz.*, the Chaukpazat Grant Company, under Mr. Wright's syndicate; this is situated near the small village of Padeingon, about 12 miles north of Nankan in the Wuntho township.

A number of applications for prospecting and gold mining grants are now filed in this office. The survey of these blocks will be taken in hand as soon as it is safe to enter the country at the beginning of the field season.

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373. The traverse surveys done during the season amount to 1,620 square miles, *viz.*, in Yamethin 815 square miles, in Shwebo and Yeu 507 square miles, in Katha 115 square miles, in Upper Chindwin 178, and in the gold fields 5 square miles. The whole of this area, with the exception of 330 square miles, has been surveyed cadastrally on the 16-inch scale this season. It has been found difficult to keep the traverse survey much in advance of the detail survey when such large areas of detail are turned out each season. In order to provide a sufficient amount of advance traverse for next season, 1,200 square miles of traverse work in Myingyan district has been made over to this party by No. 12 Party.

374. All theodolite traverse stations were permanently marked by embedding baked clay cylinders, 38,536 of which were laid down during the field season. The number of linear miles of boundary traverse survey is 5,193, and the number of angular observations is 46,208, which were checked by 246 observations for azimuth, connections being made on five Great Trigonometrical stations for the purpose of checking the linear measurements.

The mean error of direct distances between the Great Trigonometrical and traverse survey is 2·16 feet per mile.

375. The embedding of cylinders at traverse stations in the Kyaukse district, where they had been destroyed or lost since the survey was made in 1889-90, was started again this year in the Paukmyaing township and completed. The copies of the cadastral sections showing the old and new stations have been made and submitted to the local authorities.

376. The detail of the whole outturn of the season is shown in the following tabular statement:—

Localities.	Traverse survey.		Cadastral Survey, 16 inches=1 mile.			Remarks.
	Number of villages.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.	
Yamethin . . .	705	815	932	485,872	1,002	Completed.
Meiktila . . .	...	...	95	22,253	95	
Upper Chindwin . .	Surveyed in blocks.	178	254	233,792	150	
Katha	Ditto .	115	135	114,764	163	
Yeu and Shwebo . .	Ditto .	507	72	77,245	239	
Katha (Gold fields) . .	Ditto .	5	...	...	5	Surveyed on 8-inch scale.
Total .	705	1,620	1,488	933,926	1,654	

This large detail area, surveyed on the 16-inch scale and scattered over six districts, consists mostly of cultivation without any large tracts of hills or jungle.

377. The holding-markings, writing of records, and register of crops and areas of the greater part of this area has also been done this season, on which a large number of Burmans have been employed both in the field and office.

378. The cost-rates per square mile of traverse and cadastral survey in each district are as follows:—

Meiktila (cadastral survey only), ₹99·4; Yamethin, ₹161·2; Shwebo and Yeu, ₹95·8; Katha, ₹150·1; Upper Chindwin, ₹171·1.

The cost of the cadastral survey including traversing and mapping for all the districts is ₹151 per square mile; that of the record-writing including holding-marking is ₹17·75 per square mile.

The average size of the field for the whole of the season's work is 0·63 of an acre.

379. Local labour was more extensively employed this season than formerly and cost 4 annas and 6 annas per diem when the villagers worked round about their villages, but when they were called upon to go any distance from their homes or were employed on jungle clearing they were paid at the rate of 8 annas per diem per man.

Any number of labourers could be obtained at these rates under the above conditions in the districts. Experience has shown that year by year local labour is becoming more easy to procure, and that eventually there will be no necessity to import any but the trained hands for survey work in Upper Burma. This alone will reduce the cost of survey considerably and bring the rates in Burma more on a par with those of similar surveys in India.

380. At the request of the Irrigation Department, 4-inch plans of the remaining portions of the Yeu district were made and supplied to that Department; during the present field season 41 of these in the Yeu district were submitted and the total number of sheets submitted up to date is 161. The area of the 4-inch plans contained in the 161 sheets is as follows:—Yeu, 800 square miles; Sagaing, 176 square miles, and Shwebo, 1,520 square miles, making a total of 2,495 square miles, all on the 4-inch scale for irrigation purposes.

381. As the greater part of the open country, over which the 16-inch survey is now passing in the Yamethin and Pyinmana district is, it is believed, likely to come under irrigation, it has been decided to project the graticules of the standard sheets of that portion of the country on the 4-inch scale, instead of on the 2-inch scale, as has hitherto been done. These 4-inch sheets, when completed, can be reduced to the 2-inch scale by photography, and then again redrawn on an exaggerated size for reduction to 1-inch scale for publication.

382. At the request of the Financial Commissioner, a survey class for the instruction of officers of the Land Records Department was established at Yamethin under Mr. Connor, where each branch of the survey operations was in progress. The following officers who held posts of Superintendents of Land Records, *viz.*, Mr. Thisselle, Moung Do Kaing, and Maung Tha Da Pru, were put through a course of training and instructed in all the details of a traverse and cadastral survey. After undergoing three months of field and office work, these Superintendents presented themselves before the Board of Examiners at Rangoon and all successfully passed the examination in surveying.

383. The health of the party was fairly good in all the six districts up to the middle of April. The camps in Yamethin and Pyinmana continued to keep in good health throughout the season, as little or no rain had fallen in those districts; but it was not so in the Katha, Upper Chindwin, and Yeu districts, where unusually heavy and early rain set in in April inundating the lowlying valleys, and causing great sickness in the field. Work was continued under great difficulties until the middle of May, when several deaths occurred suddenly, causing a great scare amongst the cadastral contract hands, who came in in squads and refused to return to their work. Under these circumstances nothing could be done but close the work for the season.

Experience has shown that little or no survey work can be done in the northern districts of Upper Burma after April. Arrangements will therefore be made this coming season to employ a larger number of men during the healthy months in those districts, and thereby complete the required area before the setting in of the early rains in April.

384. The relations between the inhabitants of the country and the survey employès were generally of a friendly nature. Food and assistance were forthcoming when properly applied for to the headmen of the villages and few complaints were made against the survey.

385. The following maps have been prepared during the current season on the 16-inch scale with tracings, area statements and record-of-rights for the Settlement Department:—In Yamethin district, 932 sheets; in Meiktila district, 95 sheets; in Katha district, 154 sheets; in Upper Chindwin district, 120 sheets; and in the Yeu district, 112 sheets; total of all the districts, 1,413 sheets. Standard sheets on the 2-inch and 4-inch scales have also been prepared as follows:—in Meiktila 36 sheets and in Yamethin 5 sheets on the 2-inch scale, in Yamethin 34 sheets on the 4-inch scale or altogether 75 sheets for publication as standard sheets on the 1-inch scale.

386. Tracings of blocks three square miles in area, on 8-inch scale, for various firms and individuals for gold mining purposes have been submitted to the Deputy Commissioner of Katha. Tracings of 41 sheets on the 4-inch scale of lands fit for irrigation of the Yeu district were also submitted to the Superintending Engineer for Irrigation. Copies of 44 cadastral sheets showing both the old and new stations, where cylinders have been embedded in the Kyaukse district, have been made over to the Deputy Commissioner.

387. The relations with th e district authorities were of the most cordial nature in all the districts in which survey operations were in progress. Mr. Cooke expresses his obligation to Colonel Grey, Deputy Commissioner of Yamethin, Mr. Collins, Deputy Commissioner of Shwebo, Mr. Soppit, Deputy Commissioner of Katha, and to the Settlement and Assistant Settlement Officers who have worked in close co-operation with the survey. The successful season of work is due in a great measure to the aid given by these officers in the districts under survey.*

BIHAR.

NOS. 4 AND 5 PARTIES.

388. These parties continued the survey of Northern Bihar, in the districts of Muzaffarpur, Champaran, and Saran, and also furnished a detachment for the traverse survey of the Government and Tikari Ward's estates in district Gaya. The charge of the parties was held throughout the year by Captain R. T. Crichton, S. C.

The operations in each district will be described separately.

SURVEY OF THE MUZAFFARPUR DISTRICT.

389. Field work was commenced on 25th October 1894, and the return to recess quarters took place on the 30th April 1895.

Personnel.

Mr. H. T. Hanby, Extra Assistant Superintendent, 3rd grade, in charge.
„ C. S. Kraal, Extra Assistant Superintendent, 6th grade.
„ E. F. Berkely, Sub-Assistant Superintendent, 1st grade.
„ A. B. Smart, Sub-Assistant Superintendent, 1st grade.
„ C. G. Lee, Sub-Assistant Superintendent, 1st grade.
„ H. H. B. Hanby, Sub-Assistant Superintendent, 3rd grade.
1 supervisor.
5 head inspectors.
43 inspectors.
321 *amins* (local).
227 ditto (imported).

390. The season's operations were carried on in two main blocks—one in the south of the Sitamarhi sub-division and the other in Colonel Barron's survey areas of 1885-86. Also scattered work, to complete gaps of previous seasons, was carried on all over the district, except to the north.

As the season's operations in this district comprise, besides new survey and record-writing, the revision of the areas surveyed by Colonel Barron in 1885-86, by Mr. Finucane in 1878-79, and also municipal surveys; and as in each of these operations the procedure differed considerably, each will be dealt with separately.

* Mr. Cooke reports that all his assistants gave great satisfaction in the discharge of their duties. Mr. Connor had charge of the work in the Yamethin district; Messrs Swiney and Serrao supervised the operations in Shwebo and Chindwin respectivl ; M . Wilson held charge of the traverse camp; Messrs. Walsh and Baker of the work in Katha, and Mr. Powell of the survey of gold mining grants.

Of the native establishment, the writer, B. C. Chuckerbutty, the head computer, Kedarnath and Surfuraz Khan, Bholanath, Mahomed Nisarali, Mahomed Kadir, Gafur Buksh, Srikanto Banerjee, Harpat Rai, Lahori Singh, Abdul Hasssan and Rafutullah are specially mentioned.

Original Cadastral Survey and Record-writing.

391. The following statement gives the areas cadastrally surveyed with records:—

District.	Cadastral Survey, 16 inches=1 mile.			Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Muzaffarpur .	664	932,894	657·81	987	1,370,991	938·47

The excess of the figures of record-writing over survey is due to the completion of heavy arrears of previous seasons. The record-writing is now absolutely up to date with the survey, which is very creditable to all concerned.

392. The 987 villages of which records have been written during the season are mapped on 1,567 sheets. The average size of the field, calculated on the area of record-writing, is a trifle under 0·44 of an acre.

393. In the area surveyed 1,143·15 linear miles of check survey were run by Europeans and independently, and 1,462·09 linear miles by inspectors. The total linear miles of check survey is therefore 2,605·24, which gives an average of 3·96 linear miles of check survey to each square mile of detail.

The number of entries checked by the Survey officers, in all the records prepared in the field, was 17,609 and by inspectors 227,520, or a total of 245,129 entries checked, which is nearly 18 per cent. on the whole number of plots.

394. There were in all 328 boundary disputes, of which 308 have been settled and the maps and records corrected, where necessary, in accordance with the decisions.

395. The presence of water in portions of the work was a considerable source of trouble, as survey could not be started in these tracts until near the close of the field season, and, consequently, in a few villages, field work was being carried on during recess. The other difficulties entailed were due to non-attendance and the intricate nature of the tenures.

396. The recess work of this section has been exceptionally heavy, as the records of 14 *lakhs* of fields had to be dealt with in a period of five months. The difficulties of this task were, moreover, aggravated by the trouble which had to be taken in passing the areas of fields in the revision of Colonel Barron's survey, owing to the very intricate nature of the tenures dealt with.

397. The following Assistant Settlement Officers were appointed to supervise the record-writing:— Mr. Day, Mr. C. C. Warburton and Babu Chinta Haran Chatterji during the whole season, and Mr. Phillimore and Babu Khettar Mohan Pershad for portions of the season.

398. The conduct of some of the petty proprietors in bringing pressure on their tenants to either absent themselves at the time of record-writing, or to even repudiate their claims, if they had previously put them forward, was a source of considerable difficulty.

Mr. Hanby reports that he finds that the *raiyats* during the season under report showed a much keener interest in the proceedings than previously, and that they have at last arrived at an understanding of the value of their *parchas*.

399. The country in which survey operations were carried on, especially towards the south, was low-lying and fairly open, but in the immediate vicinity of Muzaffarpur it is well wooded, with numerous orchards.

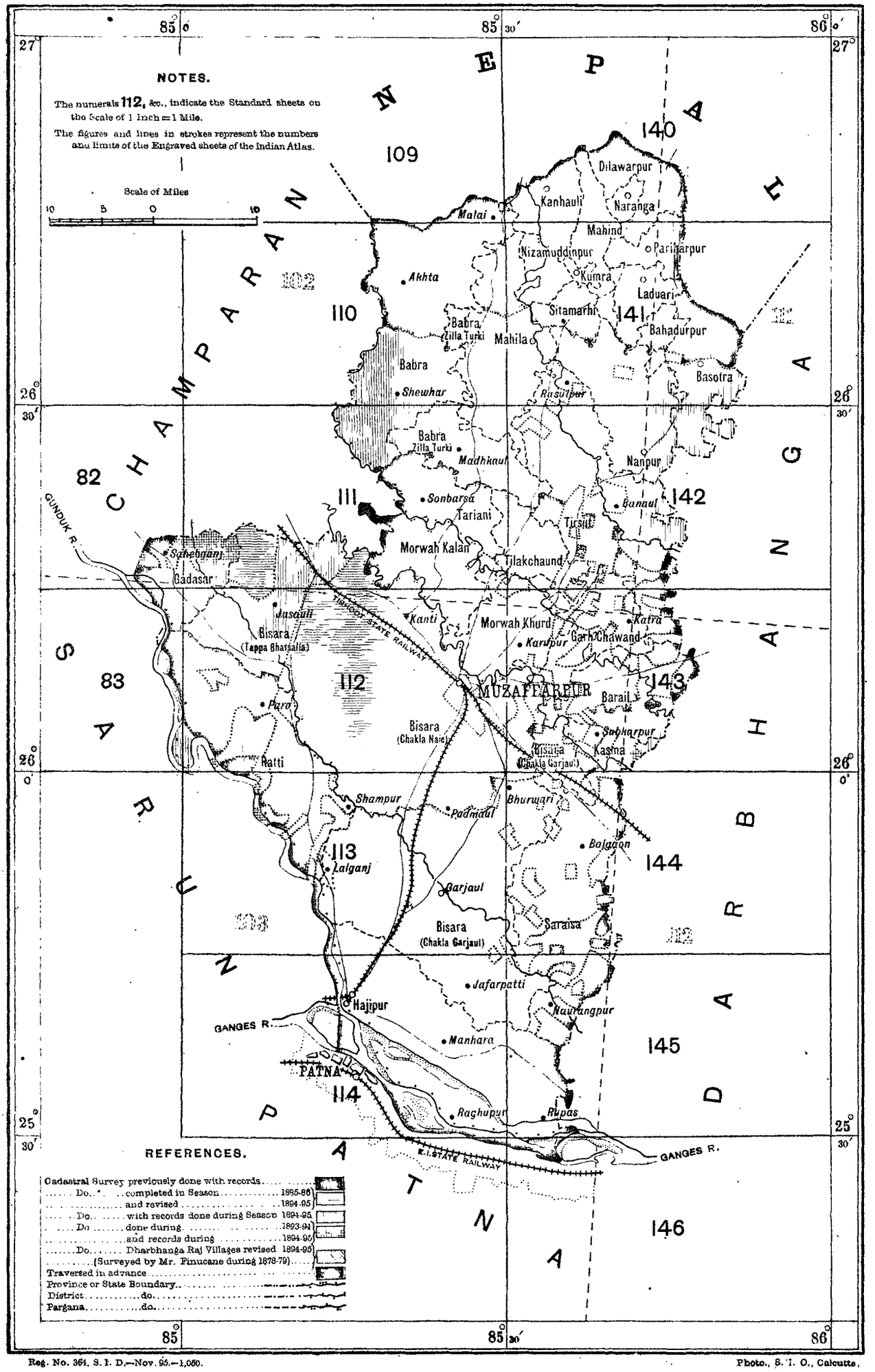
400. The total expenditure on new survey and record-writing was ₹1,19,078, of which ₹40,496 are debitable to detail survey, including completion of maps, areas, and traces, and ₹78,582 to record-writing, including completion of records and statistics, the resulting cost-rates being for detail survey, &c., ₹55·5 per square mile, and for record-writing, &c., ₹83·8 per square mile.

The actual expenditure on cooly bills has been ₹3,038-12-7, which has been included in the cost of detail survey, but this item represents, in itself, a cost-rate of ₹4-9-10 per square mile.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MUZAFFARPUR.

1894-95. Nos. 4 & 5 PARTIES.



Reg. No. 364, S. I. D.—Nov. 95.—1,050. Photo., S. I. O., Calcutta.

No. 529-S. 95.

Revision of Colonel Barron's survey of 1885-86.

401. The revision survey was accomplished during the field season under report. The following tabular statement shows the work accomplished by *tappas*:—

Tappa.	Revision Survey. 16 inches=1 mile.			Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Ghakla Garjaul .	14	13,620	6·97	14	13,620	6·97
Do. Nai .	420	506,238	257·06	420	506,238	257·06
Tappa Bhatsala .	216	244,183	146·22	216	244,183	146·22
Totals .	650	764,041	410·25	650	764,041	410·25

402. The mapping is comprised in 769 sheets. The average size of the field in this work was only 0·34 of an acre.

The original maps were on the 16-inch scale, and their correction entailed—(1)the correction on the map of boundaries of the "field" where the limits of the occupancy of the cultivator had altered since 1885-86, to accord with existing facts; (2) to survey any lands which were waste at the time of the previous survey, but which have since been brought under cultivation; (3) to survey in detail, all village sites which were shown on the old maps in block only, separating homes and homestead lands; (4) to survey all new roads and any other changes which had occurred since 1885-86.

403. The instructions for the record-writing provided for (1) rewriting of the *khewats* in accordance with existing facts with the aid of the copies of latest collectorate registers; (2) revision of the *khasras* in red ink, where there was room for entry of such corrections, otherwise preparation of supplementary *khasras* showing the necessary corrections; (3) compilation of entirely new *khatians*, as it was found that to correct the old *khatians* would lead to the expenditure of more time and money, as most elaborate comparisons would be necessary.

404. All the maps have been completed, as also the field record-writing, and the majority of the records and statistical statements have been compiled.

405. The total expenditure on this work up to date has been ₹45,765, of which ₹17,445 are debitable to detail survey, completion of maps, traces and area extraction, and ₹28,320 to record-writing, completion of records and statistics. The cost-rates per square mile, calculated on the actual areas completed of each sort of work, give ₹42·8 per square mile for survey, &c., and ₹86·0 per square mile for record-writing, &c. These cost-rates are not final; but as they are calculated on actual work accomplished, no credit being taken for work still remaining, they will represent, very nearly, the true cost-rate of this work.

Revision of maps and records of Darbhanga Raj villages originally surveyed in 1878-79.

406. In Government letter No. 879T.R., dated 22nd October 1894, orders were received to revise the maps and records of villages, the entire property of the Darbhanga Raj in the Muzaffarpur district, which had been originally prepared under the supervision of Mr. Finucane in 1878-79. It was found that only eight such villages fell within the scope of the season's operations, and their revision was undertaken. Of these eight villages, five were completed with records, the area being 7·10 square miles. The average size of the field was 0·44 of an acre.

407. The expenditure on this work has been ₹580, of which ₹183 are debitable to detail survey, completion of maps, areas and traces, and ₹397 to record-writing, completion of records and statistics. The cost-rates, calculated on the outturn accomplished in each item, are for survey, &c., ₹16·1 per square mile, and for record-writing, &c., ₹56·9 per square mile, but the above are not final rates, which can only be given when the work is completed in every respect.

Survey of the Muzaffarpur Municipality.

408. The special survey of the non-*raiyati* lands within the limits of the Muzaffarpur Municipality was undertaken.

409. The estimated cost of surveying those portions of the Muzaffarpur city, which do not fall within the scope of the settlement operations, was ₹2,485, which amount was deposited by the Municipal Commissioners in the treasury. For the above sum the Municipality is to be provided with maps on the 64-inch scale of those portions and a wall map on the 16-inch scale, including a reduction of the above large scale map and the area originally surveyed in the course of the ordinary operations for the settlement department. Also a complete register of occupancy for the entire area within municipal limits.

410. The area under settlement is contained within 8 villages comprising some entire villages and portions of others, but the whole Municipality extends over 15 villages. The entire area of the Municipality is 6·9 square miles, of which 1·67 square miles have been surveyed on the 64-inch scale and the balance of 5·23 square miles on the 16-inch scale, but in this latter area very many intricate portions have been surveyed on the 64-inch scale or enlarged to it to admit of numbering.

411. The average size of the plot is only 0·04 of an acre, which shows the intricate nature of the work.

412. The expenditure up to date has been ₹2,100, but as the work has not been completed the cost-rate cannot yet be given.

Survey of the Hajipur Municipality.

413. The survey of this city was commenced last year and the maps, etc., completed during the season under report. A wall map on the 16-inch scale, but without numbers, has been made, and for the central or bazar portion a copy of the 64-inch scale map has been prepared and a special register of occupancy written for the same.

414. The Hajipur Municipality covers 45 villages with a total area of 6·75 square miles, of which one village, Hajipur khas, with an area of 251·39 acres, comprises the bazar portion surveyed on the large scale.

415. The expenditure during the year under report has been ₹390.

Survey of the Champaran District.

Personnel.

Traverse Section.

Lieutenant C. W. H. Symonds, S.C., Assistant Superintendent, 1st grade, in charge.

15 surveyors and sub-surveyors.

12 computers.

416. The area traversed during the season in this district comprises all the remainder of the cultivated portions of the district to the north, excluding those lands near the river which are subject to inundation, known as *diara* lands; also a strip of *diara* touching on district Saran to the south.

417. The particulars of the area traversed are given in the following statement:—

District.	Number of village circuits.	Number of stations.	Area in square miles.
Champaran	109	2,795	126·05

The total number of linear miles of new chaining was 506·91. The angular work was checked against 15 observations for azimuth.

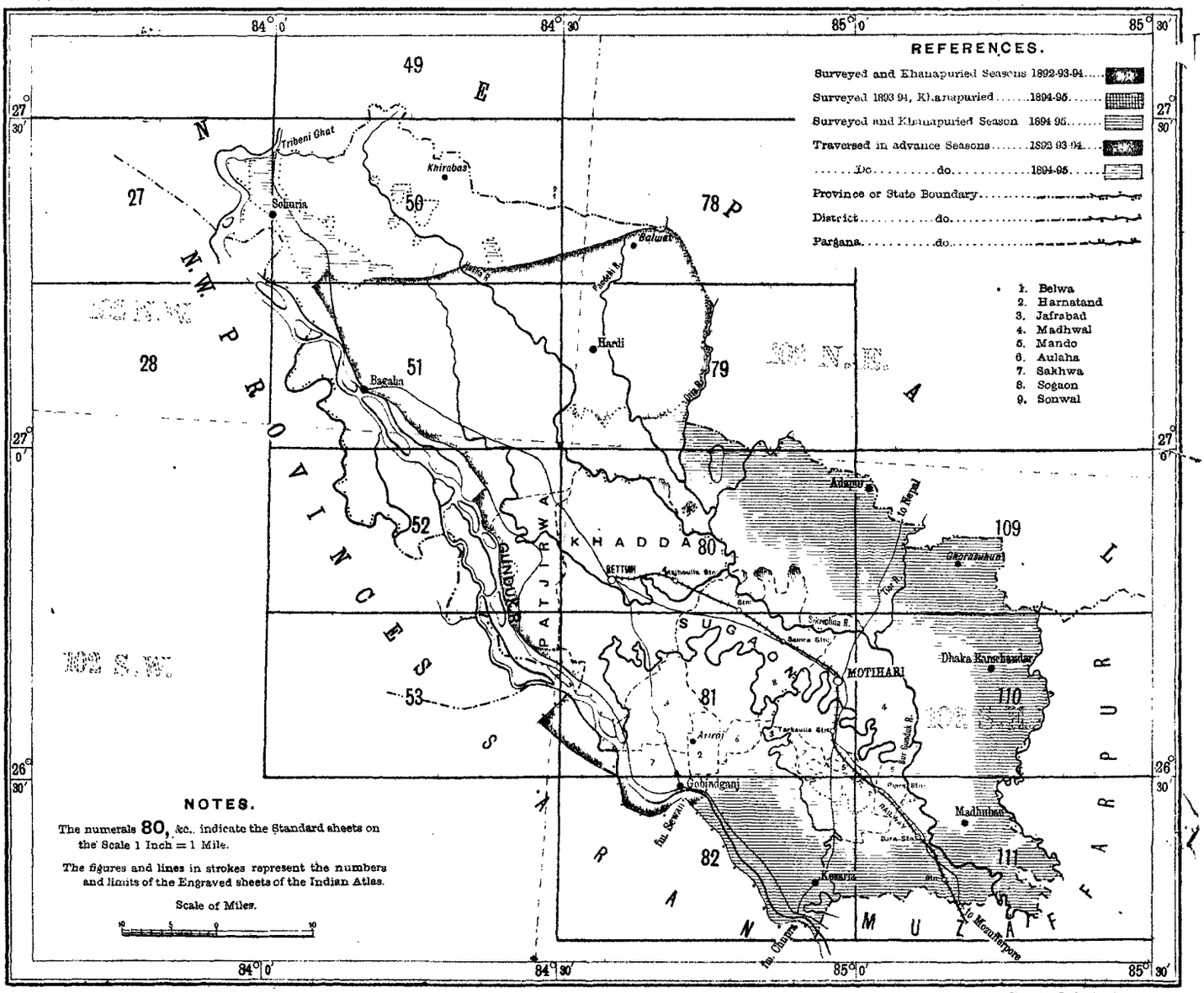
The mean variation of the magnetic needle, calculated on the 15 azimuths observed, is 2° 38′ east of the true north.

No stations of the G. T. survey were near the area under survey, and therefore no connections have been made.

418. Of the 2,215 new stations at which angles were observed, 1,783 have been permanently marked as follows:—174 tri-junction points by 141 stones and 33 large cylinders, and the balance of 1,609 ordinary stations by the 2-inch

BENGAL SURVEY.

1894-95. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHAMPARAN.** Nos. 4 & 5 PARTIES.



Reg. No. 387, S. I. D.—Nov 95.—1,050.

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No. 530-S. 95.

clay cylinders. The remaining 432 points are either on disputes, connecting lines, or in the *diara* area, and have therefore been marked by pegs only, which, on the disputed lines, will be replaced by permanent marks by the cadastral sections on settlement of the disputes.

419. The total expenditure during the season was R8,205. The resulting cost-rate is R65·2 per square mile.

420. No difficulties beyond the hilly and jungly nature of the country were experienced, but these made chaining rather difficult. Fortunately the line-clearing squads in this district, as in Saran, were put into the field a considerable time in advance of the sub-surveyors, and thus the latter were never delayed.

421. The cadastral survey was commenced on 24th October, and the retirement to recess quarters at Dinapur was begun on the 25th of April 1895.

Personnel.

Cadastral Sections.

Mr. R. B Smart, Extra Assistant Superintendent, 4th grade, in charge.
Mr. A. W. Smart, Extra-Assistant Superintendent, 6th grade.
„ J. P. Barker, Sub-Assistant Superintendent, 1st grade.
„ C. S. Gasper, ditto ditto, 2nd grade.
4 head inspectors.
42 inspectors.
200 *amins* (local.)
223 *do.* (imported).

422. The area cadastrally surveyed is comprised in a strip of country averaging 15 miles in breadth along the southern and north eastern boundaries of the district.

423. The following is the outturn with records :—

District.	Cadastral Survey. 16 inches=1 mile.			Record-writing.		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Champaran . .	1,038	1,341,030	1,161·71	1,058	1,355,443	1,176·43

The excess of the record figures over survey is due to the completion of arrears of the previous season.

424. The 1,038 villages surveyed during the season are mapped on 1,945 sheets. The average size of the field is 0·56 of an acre.

425. In the area surveyed 1,793 linear miles of check survey were run by European officers and independently, and 3,136 linear miles by inspectors. The total linear miles of check survey is therefore 4,929, which gives an incidence of 4·24 linear miles check survey to each square mile of detail survey.

The number of entries checked in all the field records by European Survey officers was 7,542, and by inspectors 306,734, or a grand total of 314,276, which gives an average of 23 per cent. on the whole number of plots.

The Assistant Settlement Officers also checked entries in the field, but their figures are not forthcoming for this report.

426. The demarcation had been originally done by the inhabitants themselves prior to traverse survey, and the temporary marks were renewed, also by the inhabitants, prior to cadastral survey. The demarcation was found to be generally very good.

427. During the operations 379 boundary disputes cropped up and were despatched to the Settlement Department for disposal. Of these, 371 have been settled and the maps and records corrected when necessary in accordance with the decisions. The majority of these disputes comprised large tracts of land on the Muzaffarpur-Champaran boundary surveyed during the season.

428. Traces and records of the entire season's work have been despatched to the Settlement Officer, and there are now absolutely no arrears of work in this district, which is highly creditable to all concerned.

429. Four Assistant Settlement Officers, *viz.*, Syed Abdul Salik, Himanshi Nath Chakarvarti, Narindra Kumar Ghose, and Habibul Rahman, were appointed to supervise the record-writing. They were all new to the work, but have co-operated fully with the section officers.

430. No exceptional or unforeseen difficulties beyond non-attendance were experienced, and had it not been for the unhealthiness of the northern tract late in the season, on account of which the field work had to be closed, the whole 1,200 square miles expected would have been accomplished.

The tract under survey was generally low lying and swampy, being intersected by numerous small streams.

431. The total expenditure during the season in this district was ₹1,56,858, of which ₹76,365 are debitable to detail survey, including completion of maps, areas, and traces, and the balance of ₹80,493 to record-writing, completion of records, and statistics, the resulting cost-rates being for detail survey, etc., ₹65·6 per square mile, and for record-writing, etc., ₹68·4 per square mile.

432. No labour was supplied free in this district. Three coolies were provided for each *amin*, and were paid 1½ annas each per diem.

The expenditure on labour has been ₹10,821-13-3, which amount is included in the cost of detail survey, but this sum represents in itself a rate of ₹9-5 per square mile.

SURVEY OF THE SARAN DISTRICT.

433. The traverse survey was commenced on the 23rd October 1894 and the detachment returned to recess quarters on the 15th April 1895.

434. The area traversed lies generally along the eastern side of the district, excluding the riverain portions. The following statement gives the particulars of the traverse survey:—

DISTRICT.	No. of village circuits.	No. of stations.	Area in square miles.
Saran	1,054	18,203	516

The total of the linear miles of new chaining was 2,550. The angular work was checked by 57 azimuths. The mean variation of the magnetic needle, calculated on all the azimuths observed, is 2° 8′ east of the true north.

A connection was made with one Great Trigonometrical station, *viz.*, Harihar Nath temple, and its value was incorporated in the traverse tables.

435. Of the 13,957 new stations at which angles were observed, 13,495 have been permanently marked. Of these, 1,687 were tri-junction points at which 598 stones and 1,089 large cylinders were embedded, and the balance of 11,808 stations were marked by the 2-inch clay cylinders.

In addition to the above, 462 stations on disputed lines were temporarily marked by pegs, which will be replaced by permanent marks by the cadastral sections when the disputes are decided.

436. The total expenditure during the season was ₹15,238, the resulting cost-rate being ₹29·5.

437. Sub-traverse stations within the village circuits are very numerous, as sub-traverse lines were not permitted to be more than 30 chains apart.

438. The demarcation notices distributed by the Collector called upon the inhabitants to demarcate their own boundaries by erecting temporary mounds of earth with a bamboo in the centre at every bend of their village boundaries. As a rule, the demarcation was found very good.

439. Very nearly all the computations of the season's work have been completed. The little that remains will be completed as soon as the necessary chain revisions have been effected.

SURVEY OF THE GAYA AND PATNA DISTRICTS.

440. The traverse operations in connection with the survey of the Government estates in the Gaya district and the Tikari Ward's estates in the Gaya and Patna districts were carried on during the season by the detachment which performed the traverse surveys in Champaran and Saran districts. The cadastral operations in connection with these surveys have already been reported on under the head of Nos. 2 and 8 Parties, by which they were carried out.

BENGAL SURVEY.

1894-95. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT SARAN.** Nos. 4 & 5 PARTIES.

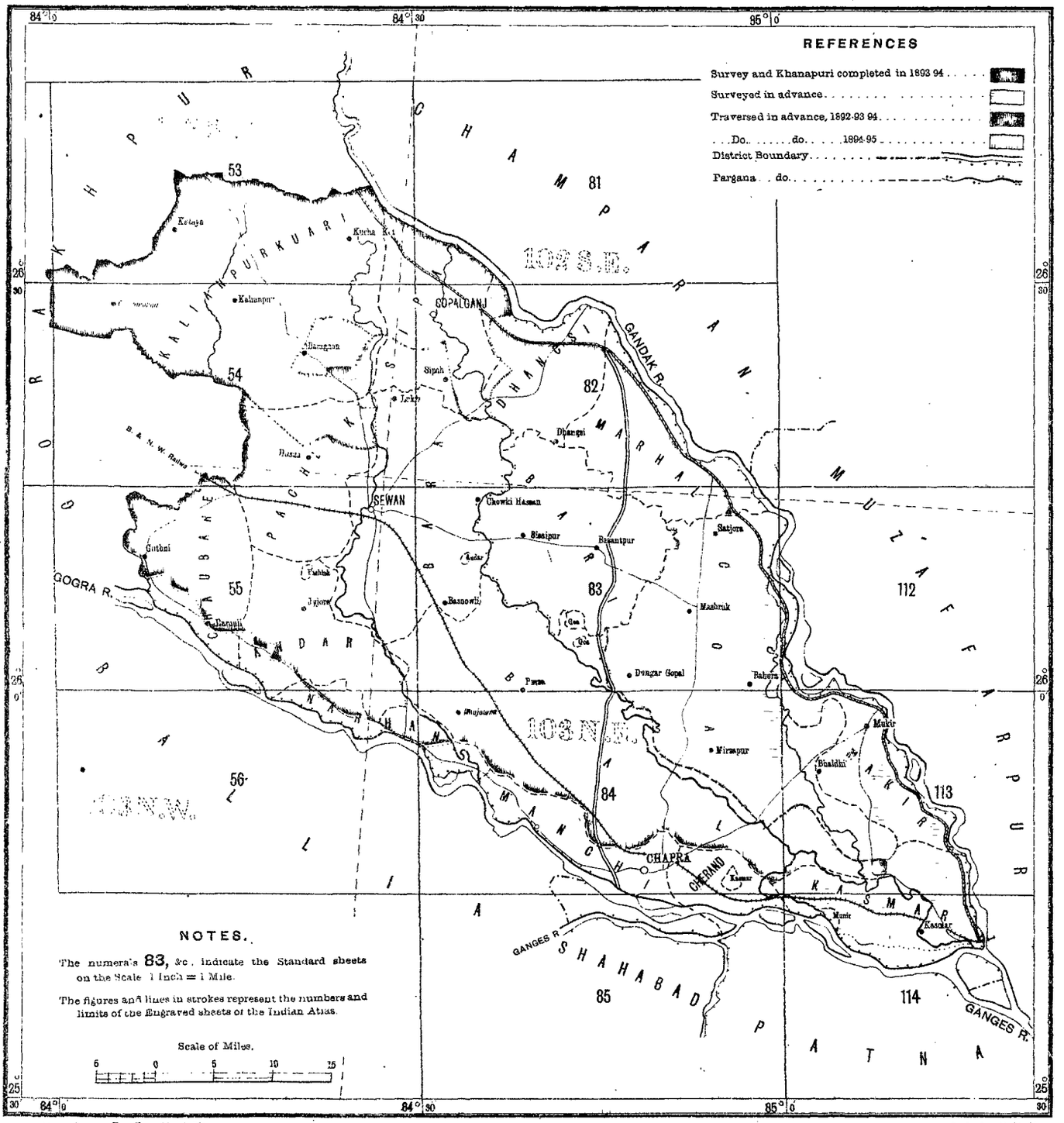


Photo., S. I. O., Calcutta

No. 557-S. 95.

Traverse Survey of the Government Estates.

441. The outturn of work accomplished in the Government *mahals*, comprises 113 villages, having an area of 89 square miles. The survey was notified in the *Calcutta Gazette* of 10th October 1894, and re-gazetted in Notification No. 4029L.R., on the 28th August 1895. These Government *mahals* consist of two main blocks and numerous scattered villages.

All blocks and detached villages have been connected with the traverse work of the Tikari Ward's estate in the district.

Besides the bearings obtained from the connecting lines, there were nine observations for azimuth taken and the angular work was proved against these "bearings." There were 514·50 linear miles of new chaining. The theodolite was set up 3,497 times, or excluding starting and closing angles, at 2,977 new stations.

442. Of the above new stations, 2,149 have been permanently marked, *viz.*, 365 tri-junction points by stones, and 1,784 ordinary stations by 2-inch clay cylinders. The balance of 828 stations were marked as follows, *viz.*, 49 points by marks cut in rocks *in situ*, and 779 disputed points by pegs. A considerable amount of jungle and hills were met with in parts, and owing to the scarcity of good roads and the scattered nature of the work, there was some trouble in the conveyance of station marks.

443. The total expenditure during the year under report has been R5,095, the resulting cost-rate per square mile being R57·2.

Traverse Survey of the Tikari Ward's Estates.

444. The traverse operations in the Tikari Ward's estates in the Gaya district were in continuation of those of previous seasons. The work accomplished is in 49 villages with an area of 28·47 square miles. The 49 villages traversed are scattered all over the district, and are omissions from the traverse operations of previous seasons. There were 150·56 linear miles of new chaining. The theodolite was set up altogether 925 times, or, omitting commencing and closing angles, at 727 new stations.

445. Of the above 727 new stations, 642 were permanently marked as follows:— 116 tri-junction points by large stones and 526 ordinary stations by 2-inch clay cylinders. The remaining 85 stations are on disputes, and have been temporarily marked by pegs. The demarcation was found to have been generally badly done, and was the cause of some delay.

446. The traverse survey in the Patna district was carried on in 16 villages, having an area of 17·56 square miles. As these villages are scattered at great distances over the district, the cost of connecting them would have been prohibitive; and as the plots were urgently required for the cadastral survey, it was decided to set up each village, or block of villages, on the magnetic needle bearings. The magnetic bearings utilised were the means of several readings of the needle.

447. There are 102·68 linear miles of new chaining. The theodolite was set up at 637 new stations, of which 635 have been permanently marked as follows:—104 tri-junctions by large stones and 531 stations by 2-inch clay cylinders. The remaining two stations were disputed, and are accordingly only marked with pegs. The demarcation in this district was also carried out by the inhabitants, but very badly.

448. The traverse data are complete in every respect, and have been despatched to the cadastral camp.

449. This work was somewhat troublesome on account of its scattered nature, and also some difficulty was experienced in ascertaining which were the Tikari Ward's estate villages for survey.

450. The total cost of this work in both districts was R3,688. The resulting cost-rate is R80·1 per square mile.*

* Captain Crichton reports that Lieutenant Symonds, who was in charge of all the traverse surveys connected with the above operations, performed his duties in a very creditable manner. Mr. Hanby, who supervised the cadastral survey in Muzaffarpur, and Messrs R. B. and A. W. Smart, who had charge of the cadastral camps in Champaran, are also specially mentioned and all the other European assistants are without exception well reported on.

The native establishment as a whole gave satisfaction in the discharge of their duties.

ASSAM.

No. 6 Party.

451. Mr. E. C. Barrett continued in charge of this party until the 23rd April 1895, when he proceeded on furlough for six months, during which period Mr. W. H. Penrose held charge. The party left recess quarters at Shillong on the 16th October 1894 and arrived at Silchar on the 27th. Field operations were commenced in the Cachar district on the 1st November and continued until the 16th May 1895, when the party returned to recess.

Personnel.

Mr. E. C. Barrett, Superintendent, 2nd grade, in charge up to 23rd April 1895.
Mr. W. H. Penrose, Extra Assistant Superintendent, 6th grade, in charge from 24th April 1895.
Mr. F. S. Bell, Sub-Assistant Superintendent, 2nd grade.
17 sub-surveyors, draftsmen, etc.

Temporary Establishment.

52 inspectors, draftsmen, computers, etc.
38 field surveyors (imported).
57 Ditto (local).

452. The programme for the season comprised—

(*a*) The cadastral survey of 540·5 square miles in the Sadar and Hailakandi *tahsils*, and

(*b*) The traverse survey of 330·5 square miles in the above-mentioned *tahsils*, besides 180 square miles of traverse in advance in the Sadar *tahsil*.

453. A survey class for the instruction of officers of the administration, and of local men, was opened at Silchar on the 1st October 1894, under Mr. Penrose. The following officers passed in field surveying:—

Messrs. Sammon, Kennedy, Fraser and Barnes, Assistant Commissioners, and Mr. Auley, Extra Assistant Commissioner. Also three Sub-Deputy Collectors, and 5 probationary Sub-Deputy Collectors and three *mohurrirs* and clerks. The number of local men who joined the class was 181, and of these, 20 were given employment as *amins*, 134 received certificates and 27 failed to qualify.

454. The outturn of traverse survey done during the season is shown in the following table:—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Cachar	22	181	14,378	510·5

A special traverse survey of Dhubri town, in Goalpara district, was also undertaken at the instance of the local administration.

The aggregate length of the traverse lines was 1,214 linear miles. The traverse was connected with two stations of the Great Trigonometrical Survey, and the error of the chaining was found to be 1·8 feet per mile. The angular work was checked by azimuth observations at 77 stations.

455. Stone prisms three feet long with one foot sides were fixed at 291 village tri-junctions, while 190 similar old prisms already on the ground were utilised as traverse stations. The position of all stations (with the exception of tri-junctions and stations at which old stones were utilised) is indicated by boughs of the *simal* or other quick-growing trees, planted five feet to the magnetic north of the station pegs, with earthen mounds thrown up round them.

456. The cadastral survey extended over 9 *parganas* of the Sadar and one *pargana* of the Hailakandi *tahsils*. About 161 grants were also surveyed on

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT CACHAR.

1894-95. No. 6 PARTY.

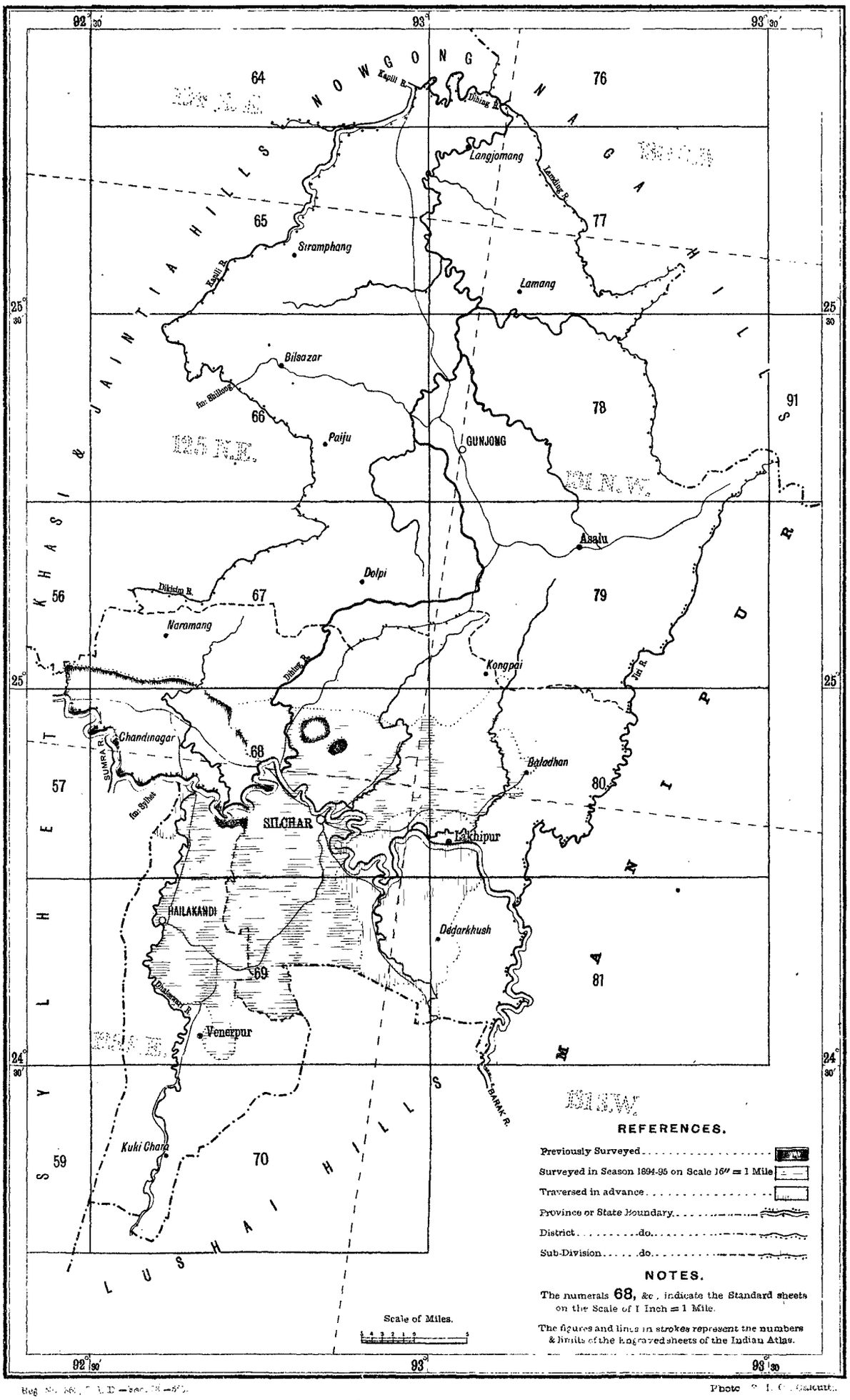


Photo S. I. O. Calcutta.

No. 331-S. 96.

the 16-inch scale. The particulars of the cadastral survey are given in the following table:—

District.	Tahsil or Pargana.	Number of villages.	Number of fields.	Area in square miles.
Cachar	Sadar	342	131,825	415·1
Do.	Hailakandi	132	88,542	125·3
Sylhet	Jaintiah	1	2	0·1
	Totals	475	220,369	540·5

457. The average daily outturn of work performed by each of the different agencies employed in the field was as follows:—

	Acres.
By Hindustani *amins*	40·87
„ Bengali „	13·38
„ *Mandals* (Assamese)	12·80
„ Survey class pupils	6·03
„ Local *amins* (old)	13·00
„ „ „ (new)	12·35

458. The season's outturn has been mapped on 692 sheets. Two copies on cloth of each map were prepared for the use of the Settlement Officer.

459. The cadastral survey was tested by 1,773 linear miles of test lines, of which 235 miles were run by European officers, 698 miles independently and 840 miles by inspectors. This gives an average of 3·3 linear miles of check survey to each square mile, or for European and independent *partal* alone an average of 1·7 linear mile per square mile.

460. The field to field survey was carried out in 9 *parganas* of the Sadar *tahsil* and in one *pargana* of the Hailakandi *tahsil*. The area completed contains about 48 square miles of Government waste. The detail survey was done by Bengali and local *amins*, under Hindustani inspectors. Twenty-five *mandals* from Assam were also employed as *amins*. The system of employing Hindustani instead of Bengali inspectors has worked well. The grants were surveyed by sub-surveyors and picked Hindustani *amins*.

461. The revision survey of the area cadastrally surveyed in the Katigora *tahsil*, Cachar district, in 1893-94, was commenced on the 3rd December 1894, by 11 *amins*, each of whom was attended by a settlement *munsarim*; the work was brought to a close on the 7th June 1895.

462. The cost-rate of the survey operations, including traverse, detail survey, mapping and completion of records, is R133·2, as compared with R183·9 for the same operations last year. The comparatively low rate for last season's work is mainly due to the larger area surveyed.

463. The programme for the ensuing season comprises the survey of about 400 square miles of cadastral and 200 square miles of traverse survey, to complete the area remaining for survey in the Cachar district. About half of this consists of grants for tea gardens, hills and dense jungle, and is most difficult country. No other work has so far been allotted to the party.

464. The attitude of the people was decidedly obstructive. During November and December an area of about 60 square miles only of traverse survey was with difficulty completed by no less than 12 boundary surveyors. The Deputy Commissioner of the district has been asked to take steps to ensure the co-operation and assistance of the villagers during the coming field season. The relations between the Survey, Settlement and district officials have been cordial.*

* Mr. Penrose, who held charge of the party during Mr. Barrett's absence, conducted his duties with complete satisfaction, and he reports that Mr. F. S. Bell rendered efficient service both in the field and recess.

The following members of the native establisnment are deserving of special mention:—

Futteh Muhammad, Krishnajee Mahadeo, Sakhawat Hossein, Khurshed Hossein, Golam Hyder Khan, Mohamed Tabrez Khan, Mohamed Ismail Khan, Janardhan Rao, Srikristo Dey, Bahadur Singh, Sarat Chunder, Kedarnath and Nilmadhub.

AMHERST AND THATON DISTRICTS, LOWER BURMA.

No. 7 Party.

465. This party was employed during the season in the new district of Thaton which has been formed out of portions of the Amherst and Shwegyin districts, and the operations (including the final mapping of the large scale survey of Moulmein town) in the late Amherst district have now been completed. The additional areas assigned for survey were found to be even larger than was expected; and being scattered over localities widely separated from each other and somewhat difficult to get about in, their completion proved no easy task, and but for a protracted spell of fine weather in May, some portion certainly would have stood over.

Personnel.

Mr. C. Wood, Deputy Superintendent, 2nd grade, in charge up to 13th April and from 12th July 1895.
„ W. C. Price, Extra Assistant Superintendent, 3rd grade, in charge from 13th April to 12th July 1895.
„ G. W. Jarbo, Extra Assistant Superintendent, 5th grade.
„ C. W. F. Seyers, Extra Assistant Superintendent, 6th grade, up to 26th April 1895.
„ J. Murphy, Extra Assistant Superintendent, 6th grade.
„ M. Gastaud, Sub-Assistant Superintendent, 1st grade.
„ T. W. Babonau (Jr.), Sub-Assistant Superintendent, 2nd grade, from 5th June 1895.
„ F. B. Powell, Sub-Assistant Superintendent, 2nd grade.
„ J. H. Murphy, Sub-Assistant Superintendent, 2nd grade.
„ M. F. Berkeley, Sub-Assistant Superintendent, 3rd grade, up to 19th February 1895.
Babu Amar Singh, Sub-Assistant Superintendent, 3rd grade.
24 sub-surveyors and others.

Temporary Establishment.

66 inspectors, draftsmen, computers, etc.
92 field surveyors.

466. The conduct of the Amherst work was entrusted to Mr. Price, that of Thaton and Pegu (another new district formed out of the remainder of Shwegyin which has thus been abolished), being divided between Messrs. Jarbo and Murphy. A small squad of Burmans, after completing the revisions required by the Settlement Department in the Amherst district, was called up to assist in the detail work of the hill gardens. The required revisions were chiefly in one circle of the work of 1891-92, which for some reason the Settlement Department could not take up before, and in 5 *kwins* of 1892-93, where, owing to defective, or an entire lack of, demarcation at the time of survey and to the spread of cultivation since, several gardens had been omitted.

467. The sections left Rangoon on 1st November 1894, and by the end of a week all the squads were on their ground. They were joined there by the head-quarters on the 5th December and by the cadastral squads on the 9th idem. The Pegu and Thaton section returned to recess quarters at Rangoon on the 15th May, and the Amherst section on the 28th idem.

468. The work of the season comprised the following operations:—In the Amherst district (as originally constituted, *i.e.*, before its disintegration to form the new Thaton district), (i) the traverse survey of 325 square miles; (ii) the cadastral survey of 611 square miles in the Yelamaing, Gyaing Ataran, Haungtharaw and Salween-Hlaingbwe townships; (iii) the topographical survey of 187 square miles on the 2-inch and 1-inch scales, and the reconnaissance of 30 square miles on the $\frac{1}{4}$ inch scale, to complete gaps in the maps as far as possible.

In the Pegu and Thaton districts, (i) the boundary survey of 679 square miles and (ii) the detail survey on the 16-inch scale of 423 square miles, besides the survey of fishery limits in 20 *kwins* which had been otherwise completed in 1893-94, in the Bilin and Byaikto townships, which now belong to the Thaton district.

469. The demarcation in all the districts was found to be fairly good, and there is no doubt the difficulties experienced in the hill gardens of four circles in the Bilin and Kyaikto townships must have been as great for the demarcation officer as for the boundary surveyors, who followed some months later. On the representation of the Executive Officer, it was decided by the Director, Department of Land Records and Agriculture, not to take up the hill gardens in any of the remaining circles of the late Shwegyin district, because of the extreme slowness of the demarcation in such difficult tracts, the prohibitive cost of traverse work therein, and because the cultivation is not sufficiently extensive to warrant the expense.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. AMHERST & THATON.

1894-95. No. 7 PARTY.

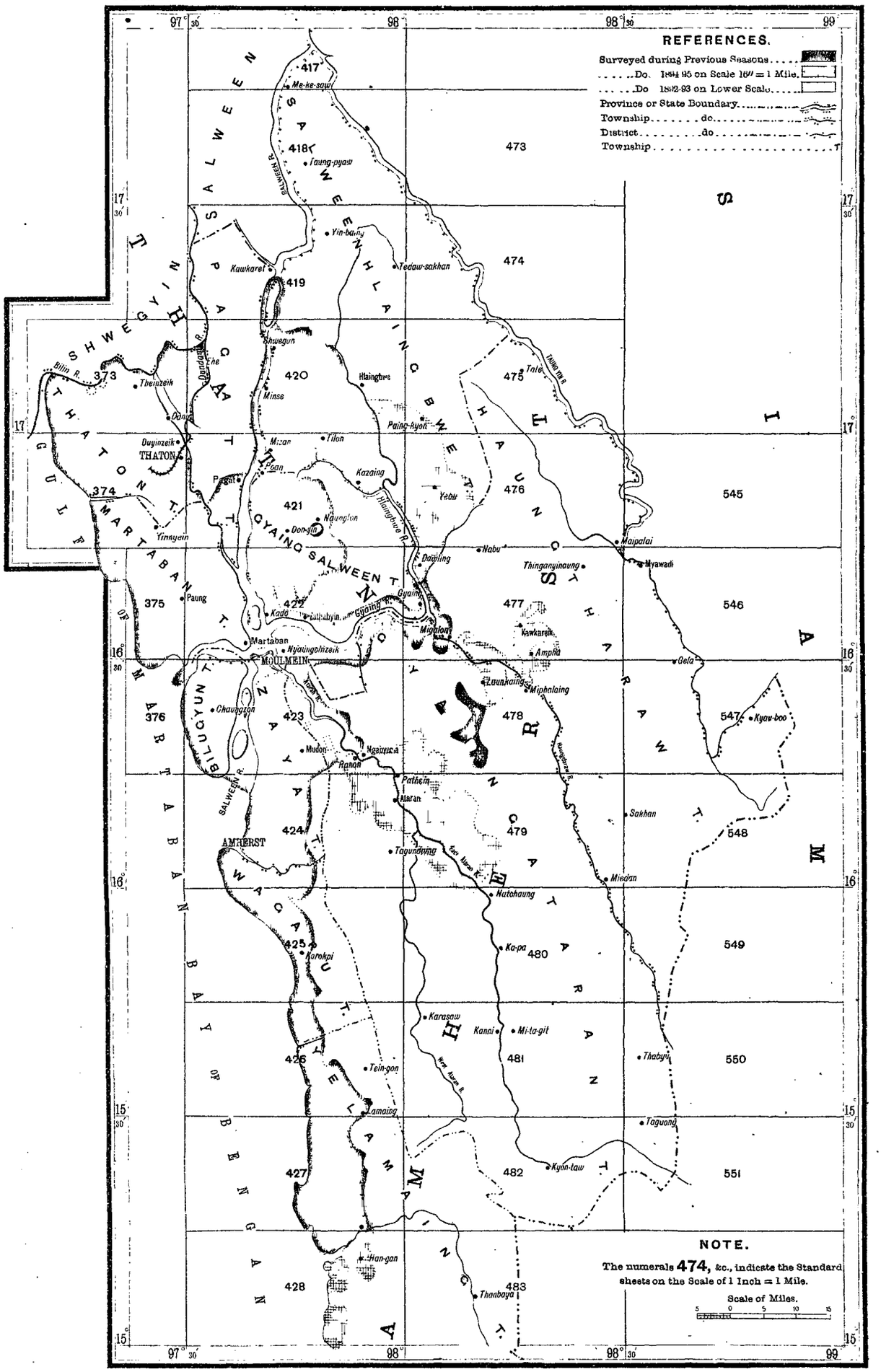


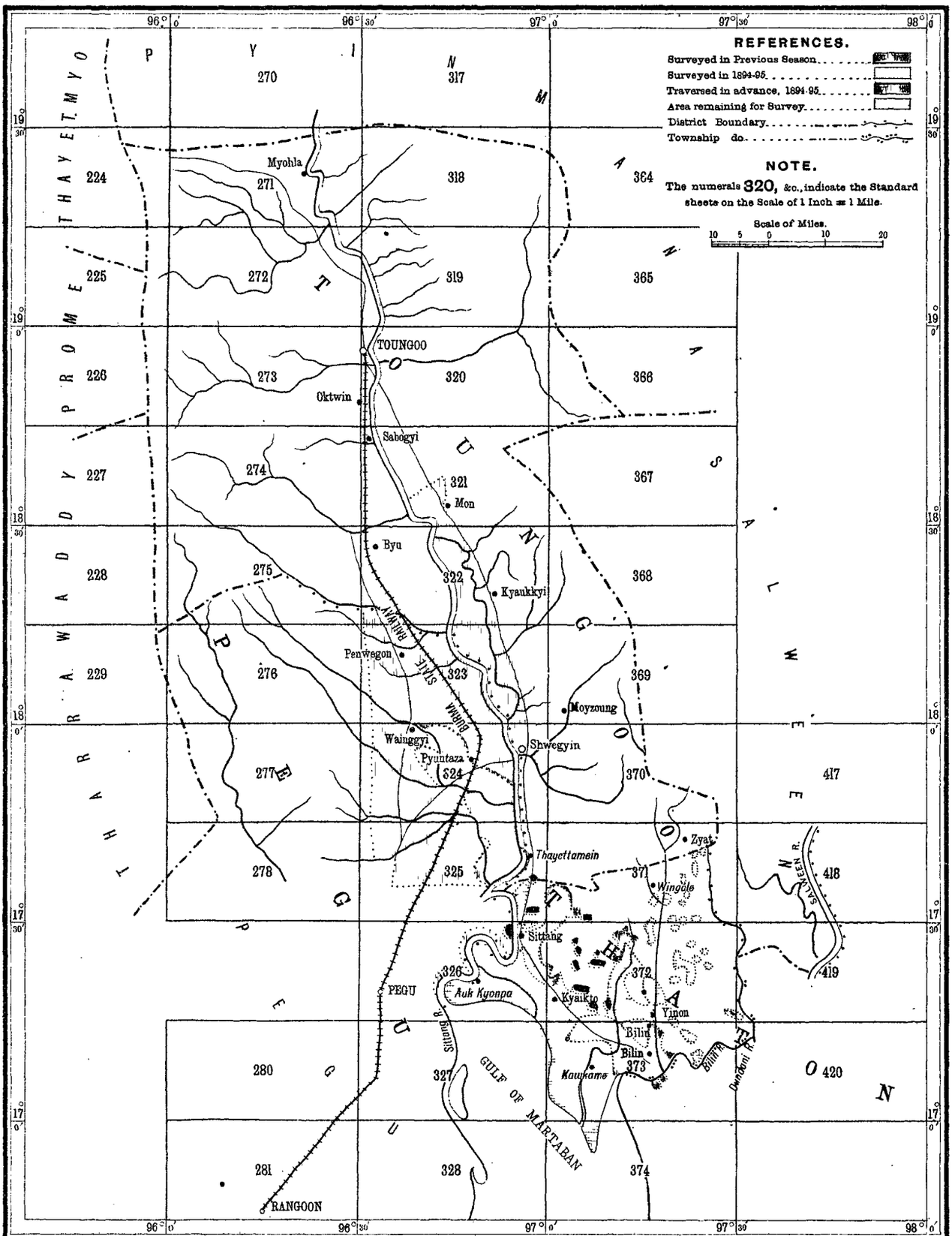
Photo., S. I. O., Calcutta.

No. 317-S. 96.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. THATON, PEGU, & TOUNGOO.

1894-95. No. 7 PARTY.



Reg No. 363, S. I. D.—Jan. 96.—550

Photo.. S. I. O., Calcutta.

No. 318-S. 96.

470. Owing to the extreme difficulty of transport, galvanized iron cylinders were exclusively used to permanently mark the stations in the hill gardens; but elsewhere about an equal number of pottery cylinders were employed. They were, as usual, eventually handed over to the custody of the *thugyis* and *ywa-thugyis*.

471. The following statement shows the out-turn of the season:—

District.	Traverse Survey.		Cadastral Survey 16 inches = 1 mile.				Topographical Survey.		
					Area in square miles.		Area in square miles.		
	Number of *kwins*.	Area in square miles.	Number of *kwins*.	Number of fields.	Cultivation.	Jungle.	Scale 2 inches = 1 mile.	Scale 1 inch = 1 mile.	Scale ½ inch. = 1 mile.
Amherst . . .	96	325	233	1,61,415	81	530	37	150	30
Pegu *cum* Thaton .	411	679	323	2,07,229	254	169	...	...	...
Totals .	507	1,004	556	3,68,644	335	699	37	150	30

472. The survey on the 16-inch scale is checked by no less than 3,052 linear miles of chain measurements of which 1,268 were done partly independently after sheets had been received in office, and partly by the European assistants.

473. The cost-rate of the traverse survey in Amherst is this year R54 per square mile, and in Pegu and Thaton R68. The former is about 10 per cent. cheaper than last year, while the high cost of the latter is attributable to the very slow and difficult character of the work in the four circles in which hill gardens had to be surveyed.

The cost-rates of the cadastral survey, calculated on the whole area, irrespective of cultivation or jungle, are R88·53 in Amherst and R123·23 in Pegu and Thaton per square mile.

In Amherst the proportion of cultivation to jungle is only as 1 to 6½, the average size of the field being 0·36 of an acre; while in Pegu and Thaton the proportion is as 3 to 2, the average size of the field being 0·8 of an acre. Calculating the cost-rates on the system hitherto adopted (*vide* paragraph 492 of last year's report), and assuming that in Amherst the cost of surveying jungle—with such a preponderance of jungle stretching over large tracts—is three times that for the same area of jungle, and that in Pegu and Thaton it is four times, the rates per square mile for the cadastral survey in Amherst will be R201, and in Pegu and Thaton R176; being a decrease in the rates in both cases. The cost of the topographical work on the 1, 2 and ¼-inch scales is R5,654, giving a cost-rate of R26 per square mile all over; the revision surveys cost R2,436; the finishing and drawing of the large scale Moulmein town survey sheets cost R2,500, while the completion of the sheets of the revised Rangoon town survey cost R500.

474. The number of Burmans and Karens actually at work on the detail survey was 36. Of these, 1 inspector and 8 field surveyors were men holding 5 years' certificates, 5 have this year qualified for the same, and with them closes the operation of Mr. Bridge's scheme; 8 were men who have now served 3 years outside Mr. Bridge's scheme; 8 were volunteers from survey schools at Yamethin, Maubin, and Henzada, entertained, in accordance with Revenue and Agricultural Department No. 1687-8 of 19th June 1894, to undergo a two years' training; and 6 were entirely new men. Thus the establishment was of a heterogeneous kind, and did not keep together long. A field surveyor of 8 years' standing had to be discharged for laziness; 4 of the 6 new men proved complete failures, and their services were dispensed with, while a fifth positively refused to work after the beginning of March; and 2 of the 8 volunteers struck work in March, alleging that they could not stand the sun. They were employed exclusively in the easy, open, flat ground. The average monthly earnings of the Burmans (excluding of course those who did not serve out the full season) during the year under report comes to R30-10-10; that of the 6

volunteers being somewhat over R29, which cannot be considered good. The average monthly earnings of the Hindustani surveyor this year amounted to R40-8.

475. It is to be regretted that the health of the party suffered considerably this year. On the day that the detail squads were coming into Kyaikto cholera showed itself, and it became necessary to lose no time in dispersing the establishment by parcelling out the work: nevertheless, within a couple of days there were 10 cases of a very bad type, out of which there were only 2 recoveries. Mr. Berkeley also had to be placed on medical leave from 19th February to 2 rd April, and on 13th June was transferred to India. Then Mr. Wood's health gave way, and he was forced to go on privilege leave for 3 months from the 13th April, the charge of the party being handed over to Mr. Price. And on 26th April, Mr. Seyers died of bowel and liver complaint while surveying on the western bank of the Sittang river.

476. At the request of the Local Government the Executive Officer assisted the Director, Department of Land Records and Agriculture, in two half-yearly examinations in surveying, for superintendents and probationers of the Land Records Department. And, as there had been so many failures in former years, at his suggestion the Local Government attached the candidates for the last examination to survey parties for a practical course of technical instruction during 8 weeks, with the result that there were only one or two failures.

477. During the recess, 1,433 sheets of the 16-inch survey in Amherst and Thaton have been examined and sent to Calcutta for publication, and before the party takes the field 1,150 more will have been similarly dealt with, thus leaving no arrears. The 80 sheets of the large scale survey of Moulmein town, and the 19 sheets of Rangoon town (brought up to date), referred to in paragraph 497 of the last Annual Report, have also been deposited at Calcutta. The latter are already published and issued to meet the urgent demands of the Deputy Commissioner, Rangoon Town Lands, for use in connection with his demarcation work for the 50 feet scale survey which is shortly to be taken up, but the publication of the former still awaits the decision of the Financial Commissioner as to the number of copies required, the charge for the publication being somewhat heavy.

The drawing of the 2-inch topographical sections of the Amherst survey is practically complete, and 14 out of the 19 standard sheets will have been lodged at Calcutta by the end of the recess; it is thought expedient to retain the remaining 5 sheets (which are otherwise ready) for a few months, as an opportunity is likely to occur to square off some gaps which were unavoidably left therein. The usual 16-inch tracings of *kwin* maps, area statements, 2-inch maps of the country cadastrally surveyed during the year, as well a $\frac{1}{4}$-inch index map of *kwins* and circles, have nearly all been supplied for both Amherst and Thaton, and the remainder will be in the hands of the Settlement Department by 15th October.

478. The party was inspected by the Deputy Surveyor-General at Moulmein in January last, who found the party in a very satisfactory condition, but was sorry to find Mr. Wood in very indifferent health. Since that time Mr. Wood's health has been still worse, and it is feared that he will be unable to take the field; this is much to be regretted as he has brought the party into a state of great efficiency and his loss will be much felt.

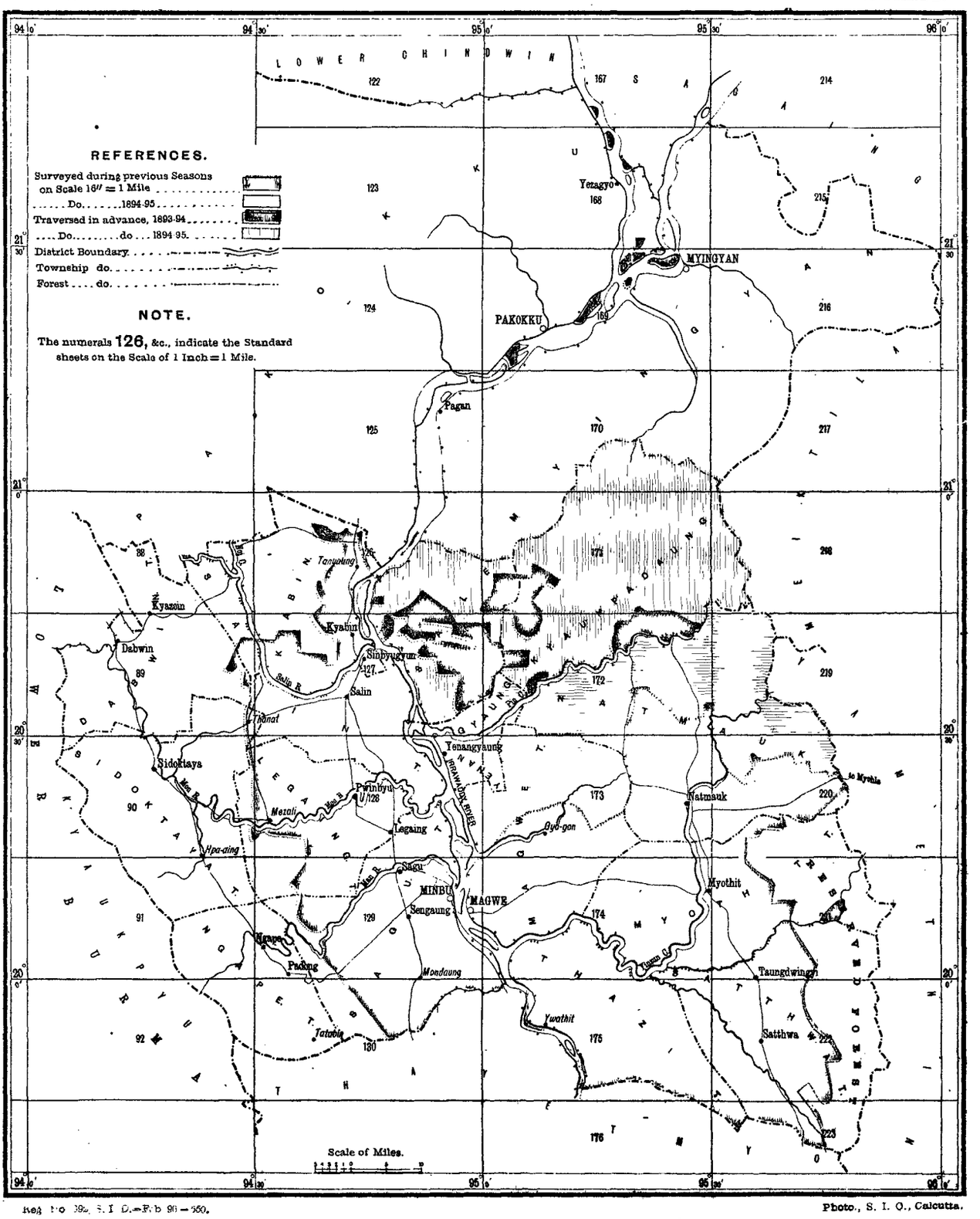
479. The President of the Rangoon Municipality has lately urged that a large scale survey of the town be made because of the increasing value of land; after considerable discussion as to the cost of doing certain portions on the scale of 50 feet to the inch and others on 100 feet to the inch, for which the Executive Officer was called upon to send estimates in detail, the Financial Commissioner decided to obtain sanction for the work to be undertaken by No. 7 Party during two consecutive seasons, for the settlement operations in Amherst had fallen more than two years behind the survey, and he thought that by the diversion of half the party in this way, the Settlement Department would make up lee way. The survey has now been notified in Chief Commissioner's No. 396-4 S.-8, dated 19th April 1895.

Thus, during the coming season one-half of the party will be employed on the large scale survey of Rangoon town, and the other half will continue operations in the Pegu and Thaton districts. The programme is to traverse

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS MINBU & MAGWE.

1894-95. No. 12 PARTY.



Reg. No. 392, S. I. O.—Feb. 96—550.

Photo., S. I. O., Calcutta.

No. 334-S. 96.

600 square miles in Pyuntaza township, and 500 square miles of detail work, including the hill gardens in the Kyaikto and Kyoupagu circles.*

MAGWE AND MYINGYAN DISTRICTS, UPPER BURMA.

NO. 12 PARTY.

480. This party left recess quarters at Mandalay for the field on 10th November 1894, and commenced operations in the Magwe and Myingyan districts between the 15th and 25th idem.

Personnel.

Mr. G. H. Cooke, Officiating Superintendent, 2nd grade, in charge, from 17th November to 3rd December 1894.
Mr. B. G. Gilbert-Cooper, Assistant Superintendent, 1st grade, in charge, from 7th December 1894.
Mr. W. S. Buttress, Extra Assistant Superintendent, 2nd grade, in charge, up to 16th November 1894, and from 4th to 6th December 1894.
Mr. E. G. Little, Extra Assistant Superintendent, 3rd grade.
Mr. G. P. Swiney, Extra Assistant Superintendent, 5th grade, up to 1st January 1895.
Mr. J. S. Swiney, Extra Assistant Superintendent, 5th grade.
Mr. A. George, Sub-Assistant Superintendent, 1st grade.
Mr. W. E. Johnson, Sub-Assistant Superintendent, 1st grade.
23 sub-surveyors and others.

Temporary Establishment.

47 inspectors, draftsmen, computers, and others.
81 field surveyors (Indian).
38 field surveyors (Burman).

481. The strength of the party is given in the margin. The party was divided into 3 sections, 1 for traverse, and 2 for cadastral survey, under Messrs. Buttress, Little, and J. Swiney respectively.

482. The programme of the field season consisted of:—

(*a*) The advance traverse survey of about 1,000 square miles in the Myingyan district.

(*b*) The completion of the Magwe district by the cadastral survey of 896 square miles.

483. The demarcation was found to be well in advance, and the demarcation officers furnished rough maps of the villages and circles, which were of considerable use to the boundary surveyors. As in previous seasons, wooden posts and piles of stones were used. All boundary disputes had been previously disposed of by the demarcation officers, under the orders of the Deputy Commissioner.

484. The cadastral survey in the Magwe district lay in the Yenangyaung, and northern portion of the Magwe, and the whole of the Natmauk townships, and was situated in the northern portion of the district adjoining that of Myingyan.

485. In the Myingyan district 905·49 square miles, comprising the Sale, and Kyaukpadaung townships were traversed in advance.

486. The outturn of work done during the season is given in the following table:—

District.	Traverse Survey.					Cadastral Survey, 16 inches=1 mile.		
	Number of villages.	Number of sub-traverse.	Number of traverse stations.	Number of skeleton plots.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Magwe	...	6	40	...	2·95	882	222,108	896·85
Myingyan	823	847	14,207	1,242	905·49	3	2,128	8·06
Totals	823	853	14,247	1,242	908·44	885	224,236	904·91

487. The average size of the circle is 7,936 acres, and that of the village is 654 acres. The average size of the field, calculated on the whole area, is 2·6; but excluding cultivated tracts the average size of the field is about 1·2 acres.

488. Of the area surveyed, about 269,795 acres or 421·55 square miles, are cultivated, and 309,344 acres or 483·36 square miles are uncultivated. All the principal cart roads and streams in the uncultivated tracts were surveyed and mapped on the 16-inch sheets.

* The Executive Officer speaks very favorably of the work of Messrs. Price, Jarbo, Gastaud, Powell and Amar Singh, making special mention of the three first named Assistants. Of the permanent native establishment, the following are commended:—C. Abrew, Faiz Buksh, Nasib Beg, Mohamed Umar, Mahbub Ali and Maung Hpokah.

489. The traverse survey was connected with two trigonometrically fixed points and the comparison of results shows an error of 8 feet per mile in the traverse measurements.

490. The angular work was checked by astronomical observations for azimuths, and the accuracy of the chain measurements was ensured by the use of two chains of different lengths.

491. There are 14,247 theodolite stations in the season's work, all of which have been permanently marked ; the average number of stations being 13 per square mile in Magwe, and 15 per square mile in Myingyan. The cost of marking stations was ₹5-0-0 and ₹4-5-10 per square mile respectively. As in previous seasons, zinc pipes have been used in the marking of survey stations.

492. Plots of village boundaries on the 2-inch scale, showing the positions of all the stations and enjoining the village *thugyis* or head-men to preserve the marks, were prepared in duplicate on printed forms, and these were submitted to the Deputy Commissioners for distribution to the *thugyis*, who were called upon to sign one copy and return it to the Deputy Commissioner's office for record.

493. This year about the same number of Burman field surveyors were employed on cadastral survey as last ; the Burmans numbering 38, and the Indians 81. The average monthly earnings of the Burman was ₹27-1-5, and that of the Indian ₹33-6-7, whilst the highest monthly earning of a Burman surveyor was ₹47-0-0, and of an Indian ₹61-11-2. The Burmans are slower and not so reliable in jungle tracts as the Indians, where they show a disposition to shirk taking lines along streams and roads. The Burman surveyors worked entirely with local men, and each Hindustani surveyor had half his squad composed of Burmans. The total wages paid to local men amounted to ₹7,867-11-0 at 4 annas per diem.

494. The field survey was tested by check lines run by inspectors as the survey progressed, followed by test lines run by the European assistants as the sheets were completed, as well as by independent check lines carried out after the field maps were lodged in office. The results proved satisfactory, as it was not found necessary to reject any sheets. There were 231 linear miles run by assistants, 2,121 by inspectors, and 704 independently, making a total of 3,056 linear miles of test survey. The average amount of test work is 3·38 linear miles to each square mile of detail survey. The sub-surveyors, inspectors, and field surveyors were periodically visited by the camp officers and assistants, as the work progressed.

495. The season's detail survey is mapped on 1,135 sheets. The drawing of these sheets has been completed.

496. As no Settlement Officer has yet been appointed for the Magwe district, the 16-inch tracings and copies of area statements of 2,234 village have been made over to the Deputy Commissioner, along with 41 tracings of the 2-inch maps of that district. The original maps and area statements have been handed over to No. 3 Party, on the transfer of this party to India, and pending the introduction of the settlement in Magwe.

497. This year 177 duplicate tracings of 16-inch sheets of Minbu were furnished to the Settlement Officer of Minbu in addition to the complete set already supplied of all the villages of Minbu last year. These additional tracings were chiefly required to replace damage and loss to those previously supplied, and no extra charge was made for them.

498. The mapping of the standard sheets on the 2-inch scale for reduction by photography to the 1-inch scale has been completed ; tracings of these have been supplied to the Deputy Commissioner, and Executive Engineer, Magwe, and the Superintending Engineer, Irrigation circle, Upper Burma.

499. The computations of the traverse surveys were all completed, and all records brought up to date ; these will now be sent for record in the Head Office in Calcutta, excepting those that it was found necessary to retain in Burma pending the introduction of the settlement in Magwe, and which will be made over to No. 3 Party along with the advance traverse records of 905 square miles of the Myingyan district.

500. The total expenditure for the survey year is ₹1,86,552. The cost-rate for traverse survey is ₹50-10-4 per square mile ; that of marking stations being ₹4-5-10 per square mile ; and the cost of the detail survey on the 16-inch

scale, including the cost of preparing records is ₹142-11-2 per square mile. The survey, both traverse and detail, on 16-inch scale has been done at a cost of 4 annas 11 pies per acre. This includes the cost of the preparations of the tracings and area statements for the Settlement Department of this year's work, as well as duplicate and triplicate tracings of portions of the work done in previous seasons in the Minbu district; and also the permanent marking of traverse stations. The total cost is considerably in excess of that of last year's. This is principally due to two causes, *viz.*:—(1) The restricted programme of operations of the party and the consequent heavy incidence on a small area of the travelling expenses of imported Indian surveyors and *khalásis*, and of the unusually heavy travelling charges on the return to India of a considerable number of temporary office hands, who had been employed continuously since the party came to Burma, but now had to be disbanded on the reconstitution of the party, on its return to India. (2) The completion of a large amount of arrears of office work, accumulated from 1890-91, for which double the number of draftsmen, estimators, and others had to be employed throughout the year, for whom increased office accommodation was required.

501. The establishment kept in good health throughout the field season; only one *khalási* having died of fever.

502. Every assistance was rendered by the villagers to the survey, and throughout the season no complaints were made to the district officers about survey employés.

503. The Deputy Commissioner of Magwe, Mr. D. J. Campbell, I.C.S., and the Deputy Commissioner of Myingyan, Mr. H. P. Todd-Naylor, C.I.E., I.C.S., are to be thanked for the very cordial aid rendered by them to the survey during the past season.

504. It having been decided that only one cadastral party would be required for the future in Upper Burma, this party is under orders for transfer to Bombay where it will commence the topographical survey of Sind.

505. The Deputy Surveyor-General inspected the party on the 3rd February 1895, at Yenangyaung, and found everything proceeding satisfactorily.

506. At the request of the Director of Land Records, Burma, two Burman Superintendents of Land Records, Maung Ba On and Maung San Shwe, were attached to the party for about five weeks for instruction in cadastral surveying on a traverse basis. The results were satisfactory. They passed their examination in surveying after having previously failed on more than one occasion.*

TRAVERSE SURVEYS.

CENTRAL PROVINCES,

No. 9 Party.

507. At the request of the Chief Commissioner, the Government of India sanctioned the retention of this party in the Central Provinces for another year, to continue the traverse survey of 847 scattered villages in *zamindári* estates and 18 forest boundaries, in districts Raipur, Chanda, Sambalpur, Hoshangabad, Nimar and Bilaspur.

Personnel.

Mr. E. J. Jackson, Superintendent, 2nd grade, in charge up to 9th January 1895, and from the 19th March 1895.
„ H. Dowman, Extra Assistant Superintendent, 3rd grade, in charge from 9th January to 19th March 1895.
„ P. A. Peters, Extra Assistant Superintendent, 6th grade, from 24th March.
„ C. George, Sub-Assistant Superintendent, 1st grade.
„ C. H. G. Johnson, „ „ 2nd „
50 surveyors, sub-surveyors and others.

508. The detachments left Kampti on the 5th December 1894 and assembled at Chanda and Raipur on the 6th idem. Field work was commenced soon afterwards. The Head-quarters Office and the establishments from Raipur

* Mr. Gilbert Cooper reports that the European Assistants have all done good work, and given every satisfaction.

The native members have on the whole worked well also. The following names are brought to notice for zeal displayed in the performance of their respective duties :—Heera Lall, (writer) Moti Lal, Abdul Waid, Golam Hyder, Makhbool Hussain, Toofail Ahmed, Ali Mahmed, Mahomed Ali, Inayutullah, and Ram Narain.

and Chanda returned to Kampti on the 4th and the camp from Sambalpur on the 11th June 1895.

509. Traverse operations were scattered over six districts. The Raipur camp covered an area of 2,686 square miles, within which only 599 square miles of scattered villages in 7 *zamindári* estates were traversed, including the villages in Hoshangabad and Nimar districts. The Chanda camp completed 765 square miles of scattered villages in 24 *zamindári* estates spread over an area of 4,619 square miles, including the villages in Bilaspur. In Sambalpur 528 square miles of scattered villages in 12 *zamindári* estates, also 18 forest boundaries scattered over 1,245 square miles, were completed.

510. The object of the traverse survey in the above districts has been, as in previous seasons, to supply the Settlement Department with skeleton plots, on the 16-inch scale, for the guidance of the *patwári's* survey. The professional theodolite stations are marked on the ground with dressed stones.

511. The traverse lines averaged from 1 to 30 chains in length and followed the boundaries closely; intermediate or sub-traverse lines were traversed in cultivable land 30 chains apart; lines also skirted the jungle. The outturn of work this season is considerably less than that of the previous season, owing to the establishment being reduced from 52 to 30 field surveyors, in consequence of the requirements of the Settlement Department being less than usual. The area of the plots supplied amounted to 1,892 square miles, the linear miles of chaining was 5,217 as against 3,397 square miles and 11,482 linear miles, reported last year. This season the villages were scattered over 8,749 square miles in 7 districts. against 5,011 square miles in 4 districts of the previous season's work. The cost-rate per square mile is ₹39-2-2, as against ₹34 for season 1892-93, and ₹26 for season 1893-94. It has been calculated for the actual area of villages surveyed, without allowance for the extra work, extending over a large area, upon which the villages were based.

512. The outturn of work for the season is shown in the following tabular statement:—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Raipur	304	400	8,676	488·73
Chanda	319	590	12,546	719·26
Sambalpur	143	204	3,667	203·36
Ditto (Forests)	18	...	650	324·61
Hoshangabad	17	19	691	29·30
Nimar	29	43	787	80·63
Bilaspur	35	49	584	45·69
Totals	865	1,305	27,601	1,891·58

513. In the above districts 21,062 dressed and 7,583 rough stones were embedded on theodolite stations, including marks *in situ*, making a total of 28,906 permanent traverse marks over a scattered area of 8549·52 square miles. The cost of 21,062 stones amounted to ₹1,159, their carriage ₹1,493, and embedding them ₹2,548, in all ₹5,200. As usual receipts were taken from the *zamindárs* for the protection of the survey stations and to ensure further protection of the professional permanent marks, 2-inch scale plots of the villages surveyed were prepared in duplicate, one copy being retained by the *zamindárs* and one by the Deputy Commissioner.

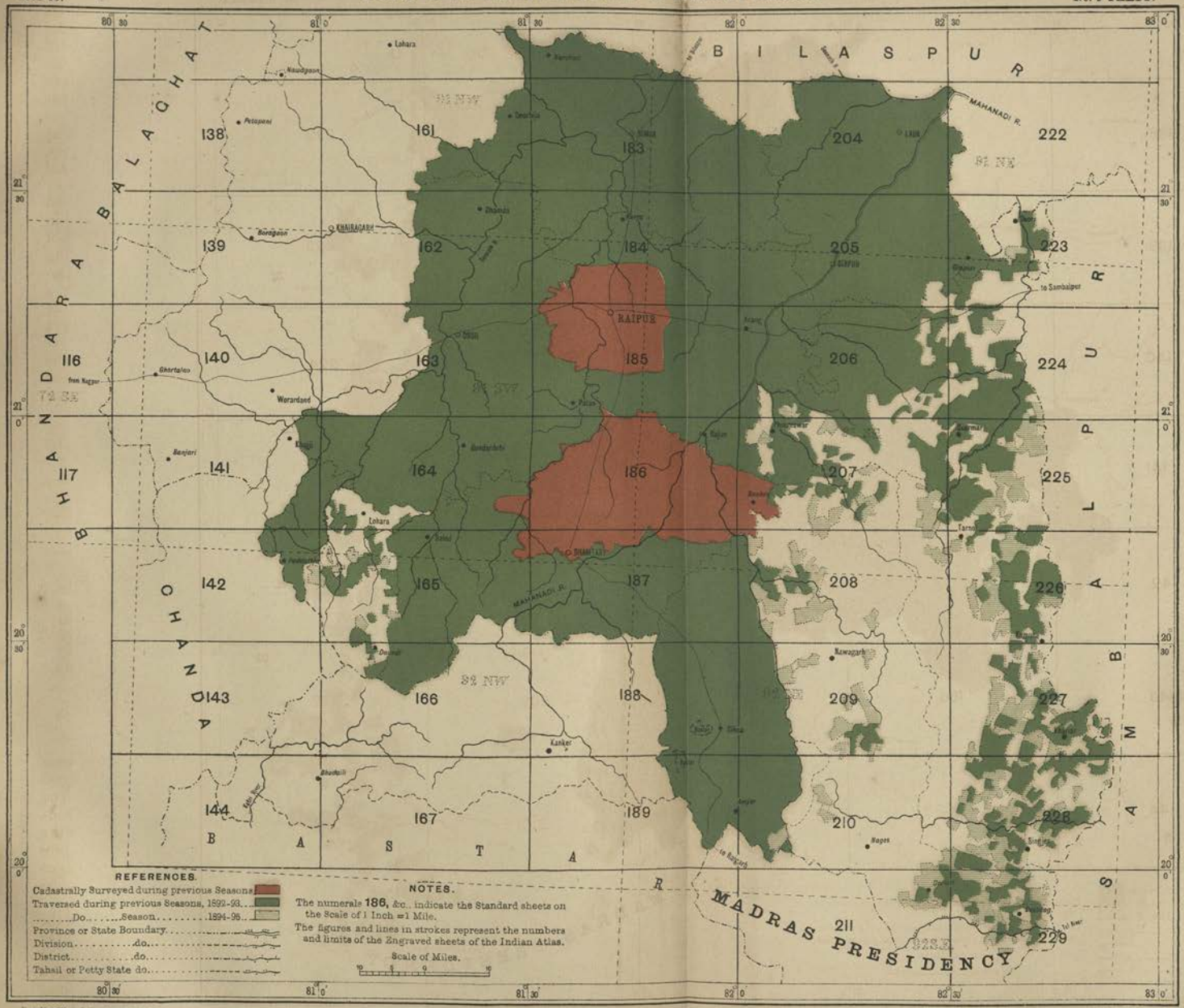
514. Two chains were used throughout, one of 100 feet in length and the other of 66 feet; 147 azimuths were observed and the computations proved the angular work to be satisfactory.

515. The Settlement Officers were unable to demarcate many of the villages, as orders for their survey were received late in the season. The *zamindárs* pointed out their boundaries, and no complaints of disputed boundaries were received.

516. The *mujmilli* maps received from the Settlement Department for the Raipur, Chanda, Nimar, and Hoshangabad districts were useless as a guide to

CENTRAL PROVINCES SURVEY.

1894-95. INDEX TO THE TRAVERSE SURVEY IN DISTRICT RAIPUR. No. 9 PARTY.



No. 316-S. 96.

CENTRAL PROVINCES SURVEY.

1894-95. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT CHANDA.** No. 9 PARTY.

Reg. No. 557, S. I. D.—Jan. 96.—550.

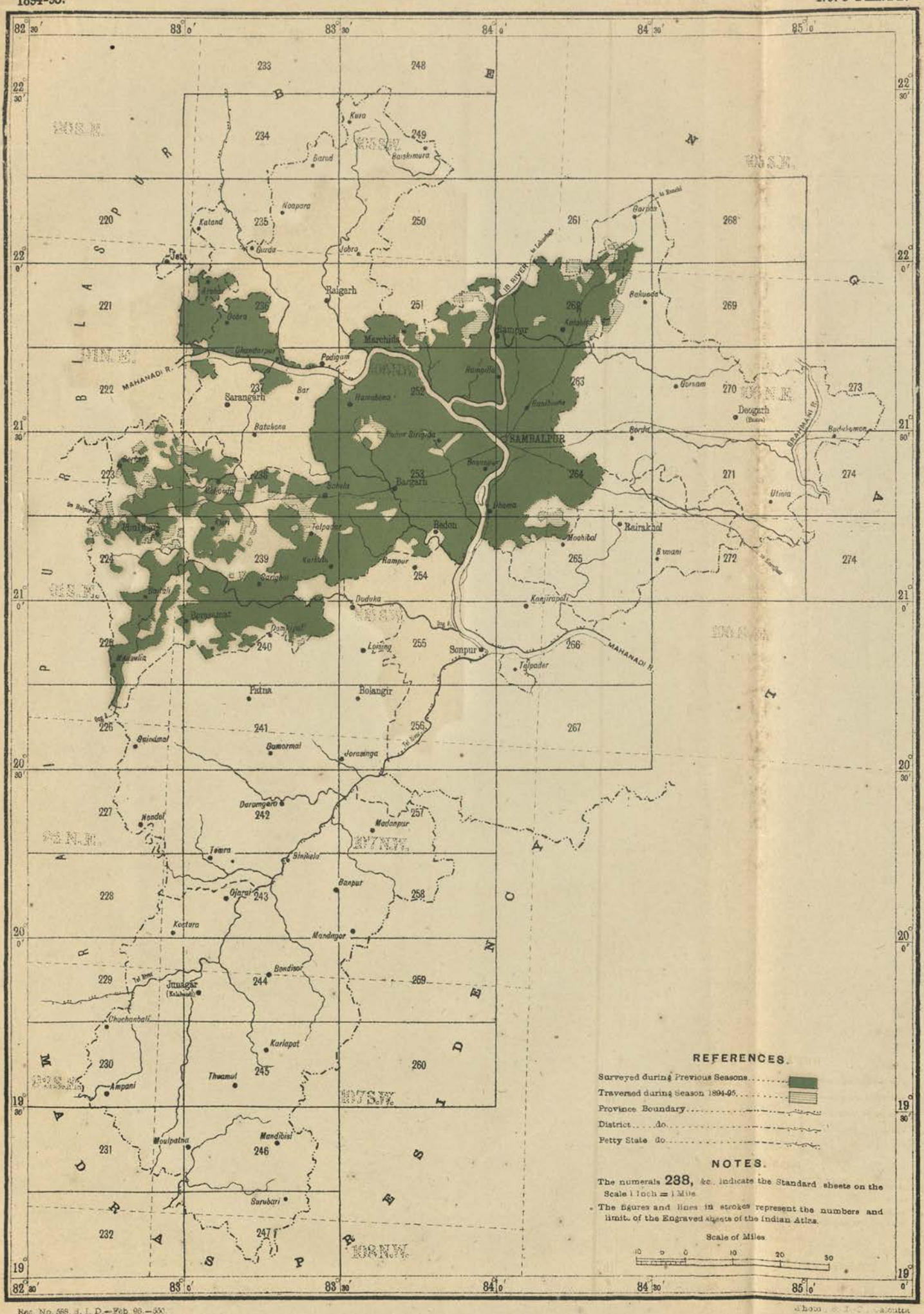
Photo., S. I. O., Calcutta

No. 330-S. 96.

CENTRAL PROVINCES SURVEY.

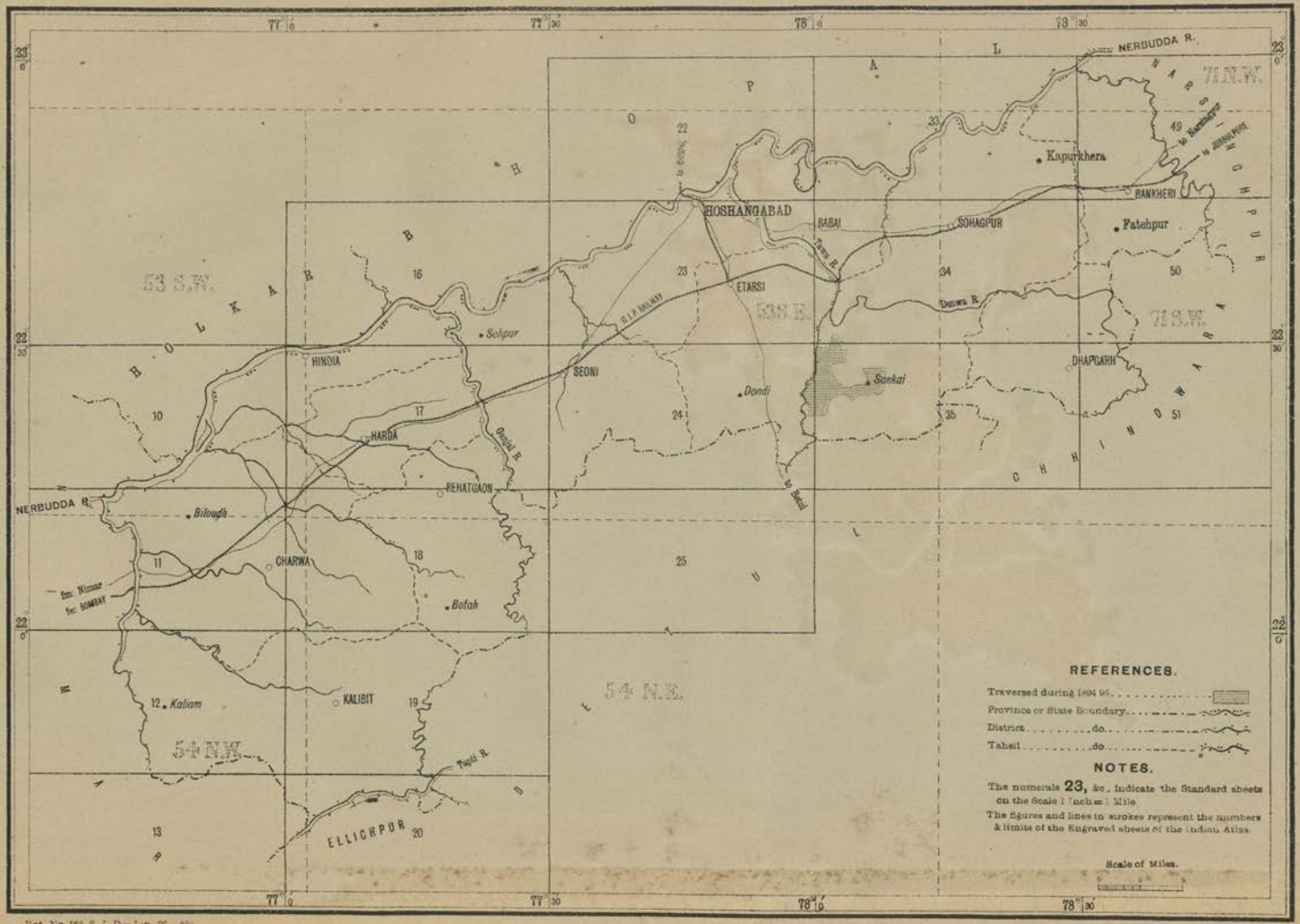
INDEX TO THE TRAVERSE SURVEY IN DISTRICT SAMBALPUR.

1894-95. No. 9 PARTY.


SAMBALPUR
BILASPUR
RAIPUR
PURI
CUTTACK
MAHANADI R.
BRAHMANI R.
Sarangarh
Bargarh
Bolangir
Sonpur
Patna
Kalahandi
Phulbani
Boudh
Deogarh
Reiraklol
Jharsuguda
Gaisilet
Rairakhol
Kuchinda
Padampur
Titlagarh
Nuapara
Baraud
Baiskimura
Katand
Jata
Gurda
Jobra
Raigarh
Marchida
Hamsabona
Batakona
Telpadar
Rampur
Duduka
Loising
Lamdaha
Bamra
Binka
Jamankira
Kolabira
Kesinga
Tumdibandh
Binaika
Kantabanji
Titilagarh
Garla
Bankuda
Gorsam
Utkela
Banki
Athmallik
Angul
Talcher
Dhenkanal
Pallahara
Chandipur
Kanjirapali
Moahibal
Sumani
Utkela
Jharsuguda
Gaisilet

CENTRAL PROVINCES SURVEY.

1894-95. INDEX TO THE TRAVERSE SURVEY IN DISTRICT HOSHANGABAD. No. 9 PARTY.



Reg. No. 568. S. I. D.—Jan. 96.—500

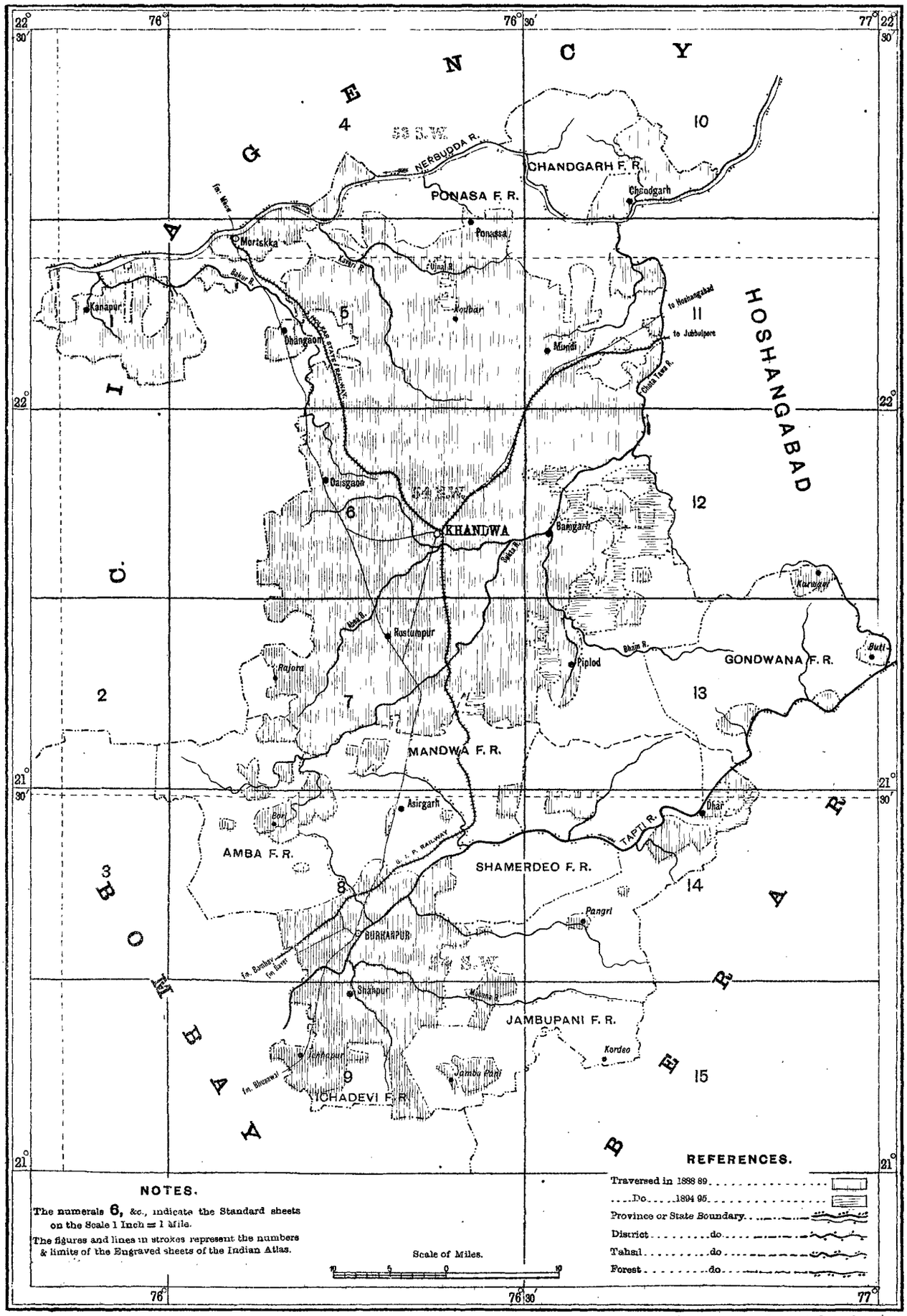
Photo., S. I. O., Calcutta

No. 310-S. 96.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT NIMAR.

1894-95. No. 9 PARTY.



Reg. No 567, S. I. D.—Jan 96.—550

Photo., S. I. O., Calcutta

No. 312-S. 96.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT BILASPUR.

1894-95.

No. 9 PARTY.

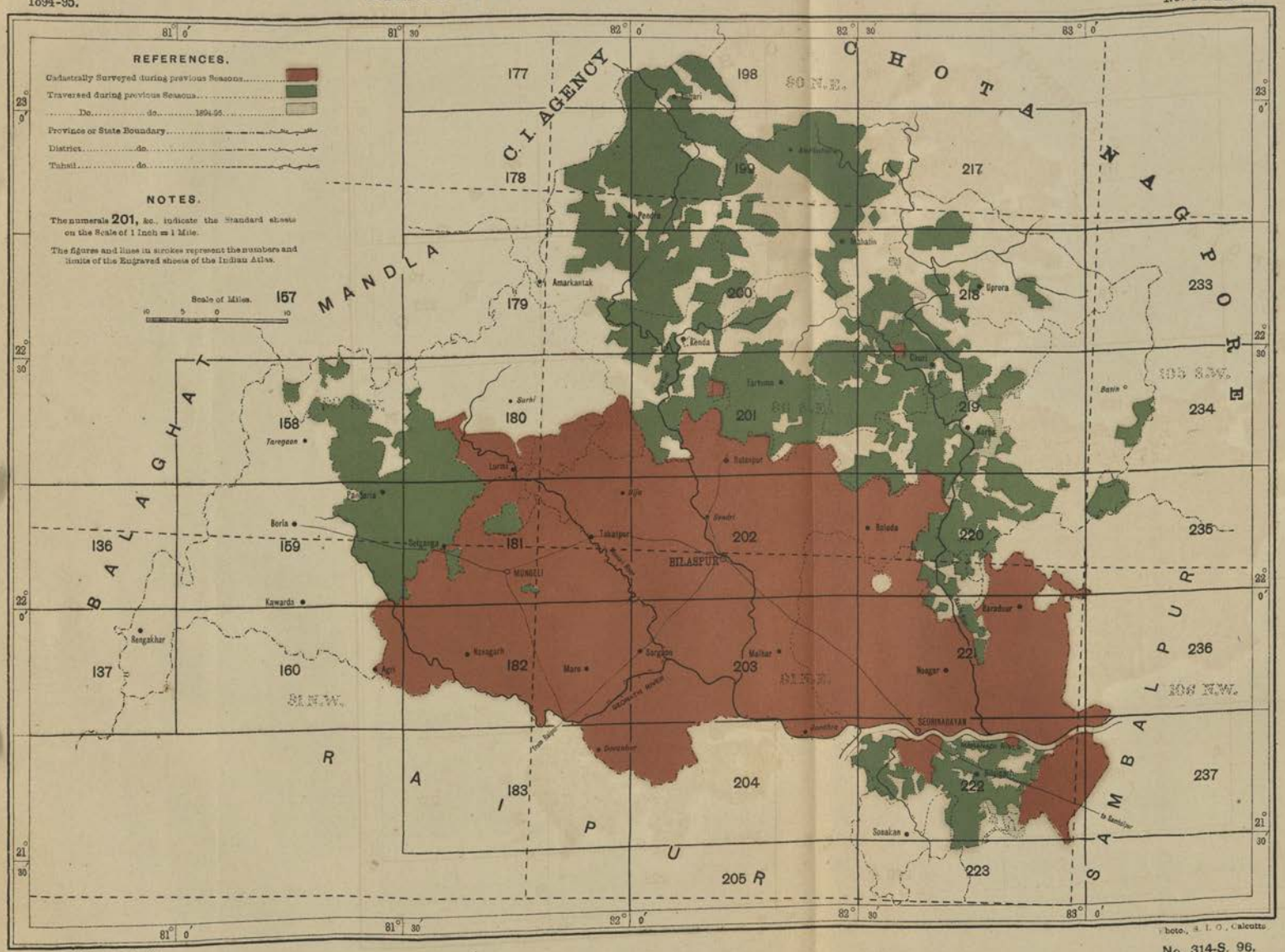


Photo., S. I. O., Calcutta.

No. 314-S. 96.

Eng. No. 518. S. I. D.—Jan. 96—550.

the surveyors, consequently maps had to be prepared from the 1, 2 and 4-inch scale topographical published maps; on these the approximate positions of the scattered villages were shown; but the positions of 70 villages in the Raipur district could not be found owing to the names not appearing on the topographical maps. This caused delay, as the sub-surveyors had to make enquiries on the ground, as the villages were scattered. The Sambalpur *mujmilli* maps received were fairly correct. The Bilaspur maps were incorrect and several letters had to be written to the Deputy Commissioner on the subject.

517. The country traversed was similar to that of the previous season, except to the south of Raipur, where the boundaries in many places run over hills. In the Sambalpur district, lines had to be cleared through jungle for the 18 forest boundaries.

518. This season the health of the establishment was fairly good, but three *khalásis* died.

519. In the field, that is up to the end of May, the 16-inch plots of 536 villages on 1,145 sheets were supplied to the Settlement Department and the remainder were submitted during the recess months.

520. The party was inspected by the Deputy Surveyor-General at Kampti on the 2nd and 3rd November; afterwards a conference was held at Nagpur on the 16th November to consider the question of allotting more work to the party so as to keep the reduced establishment employed in the Central Provinces during season 1894-95. The Chief Commissioner in his letter No. 3529, dated the 10th instant, asked for the further retention of this party for traverse work, during field season 1895-96, and the Government of India have sanctioned his request. The work to be performed will be in 761 scattered villages in the Raipur, Chanda, Sambalpur, and Bilaspur districts; also 200 square miles of scattered work, where areas are being excised from the forests for *rayatwári* settlement in 5 or 6 districts, such as Chindwara, Chanda, Seoni, Nimar, Betul, and Raipur.*

NORTH-WESTERN PROVINCES AND OUDH.

DETACHMENT.

521. From the commencement of the season a section from one of the parties in Bihar was transferred to these provinces to commence the operations which had been decided on in connection with the cadastral survey with local agency which is to follow. The section was transferred in November 1894, as sanctioned in letter No. 3326—250, dated 13th November 1894, from the Government of India to the Government of the North-Western Provinces and Oudh. It was formed into a detachment and placed in charge of Mr. J. S. Pemberton, Assistant Superintendent. The detachment proceeded from recess quarters at Mussoorie to Meerut to commence the traverse survey of that district, and of Bahraich in Oudh about the middle of November.

Personnel.

Mr. J. S. Pemberton, Assistant Superintendent, 1st grade, in charge.
„ W. J. O. Sullivan, Extra Assistant Superintendent, 3rd grade.
„ G. E. Parker, Extra Assistant Superintendent, 5th grade, from 6th December 1894.
„ G. Rae, Sub-Assistant Superintendent, 2nd grade, from 7th December 1894.
75 sub-surveyors, computers, etc.

522. The detachment was divided into two sections or camps; one, in the immediate charge of Mr. Pemberton, took up the survey of the Meerut district, the other, in charge of Mr. W. J. O'Sullivan, had the Bahraich district allotted to it. The strength of the establishment was regulated to accomplish an outturn of 3,000 square miles.

523. The general instructions as to the nature of the survey to be carried out were, that it was to be a " traverse survey, based on existing data, corrected where necessary," that is to say, it would only be necessary to do such an amount of traversing as would ensure the identity or otherwise of existing village tri-junction points with those of the last survey of 1879 to 1882. It was

* The Officer in charge reports that Mr. H. Dowman performed his duties with credit; that Mr. P. A. Peters worked to his entire satisfaction, and reports favorably of Messrs. C. George and C. H. Johnson. Of the sub-surveyors, Murlidhar, Hilaluddin, Murli Manohar, Dewa Sing, Ganpat Rai, Abdul Gafur, Mayadhari, Sadatulla and Wali Mahomed worked well. Computers Narsoo Dinkar, Lal Mohan, Upendra Nath Mukerjee, Manohar Daji and Jogendra Nath also worked well and to his entire satisfaction. Karim Bux, draftsman, and Taraprosonno Roy, writer, are also favourably mentioned.

with such instructions that Mr. T. F. Freeman, late Extra Assistant Superintendent of Survey (since transferred to the Local Government), commenced operations in the Meerut district in August 1894. When Mr. Pemberton took over charge from him on the 21st November, he had completed the survey of 264 square miles, comprising 176 villages. But it was found after several villages had been tested, that the plan of utilizing old traverse data as a basis for plots suitable for *patwâris* to work on was impracticable, first, because the tri-junction points of villages found existing on the ground were not, in the majority of cases, identical with those fixed by the old survey, for at the time of the last survey these points were in some instances not permanently marked, or, where marked, the platforms had since been destroyed and the sites obliterated; and secondly, because the plots of tri-junction points *only* would have been too few and too far distant one from the other to be of any practical use to the detail surveyor in so highly cultivated a district as Meerut, where the view in almost every direction is intercepted by standing crops or groves of trees. Moreover, it was found that the labour involved in the attempt to use existing data, which was so defective, was nearly as great as would be entailed by an entirely new survey. In the district of Bahraich, where the available data was from 26 to 30 years old, there were similar objections to the attempt being made to utilise it, therefore Mr. G. B. Scott, Superintendent, Land Records Surveys, after careful investigation, advised an entirely new traverse survey being made. Orders were accordingly issued for a survey *de novo* of every village. It may be mentioned that by this time, *i.e.*, about the 15th January 1895, 571 villages, aggregating 864 square miles, had already been traversed and the computations based, either on needle bearings corrected for variation, or on bearings deduced from old data. The whole of the computations of this work had subsequently to be re-done.

524. The field work, not reckoning the area traversed by Mr. Freeman, was not fairly started till about the 24th December 1894 in both Meerut and Bahraich, and was brought to a close on the 5th and 10th May 1895, respectively, when the establishment retired to recess quarters at Naini Tal, where office opened on the 13th May.

525. The outturn of the season in both districts is given in the following statement :—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Linear miles of traverse.	Area in square miles.
Meerut (N.-W. P.) . .	1,262	1,416	21,860	5,152	1,728
Ditto (River blocks) . .	17	...	266	82	59
Bahraich (Oudh) . .	1,246	1,940	21,765	5,253	1,298
Ditto (River blocks) .	1	...	75	27	41
Totals .	2,526	3,356	43,966	10,514	3,126

526. The total expenditure, including all charges incurred by the detachment from 1st November 1894 to 30th September 1895, amounts to R66,765-13-11, giving a cost-rate per square mile of R21-5-9.

527. The average area of village circuits in Meerut is 1·37 and in Bahraich 0·97 square miles.

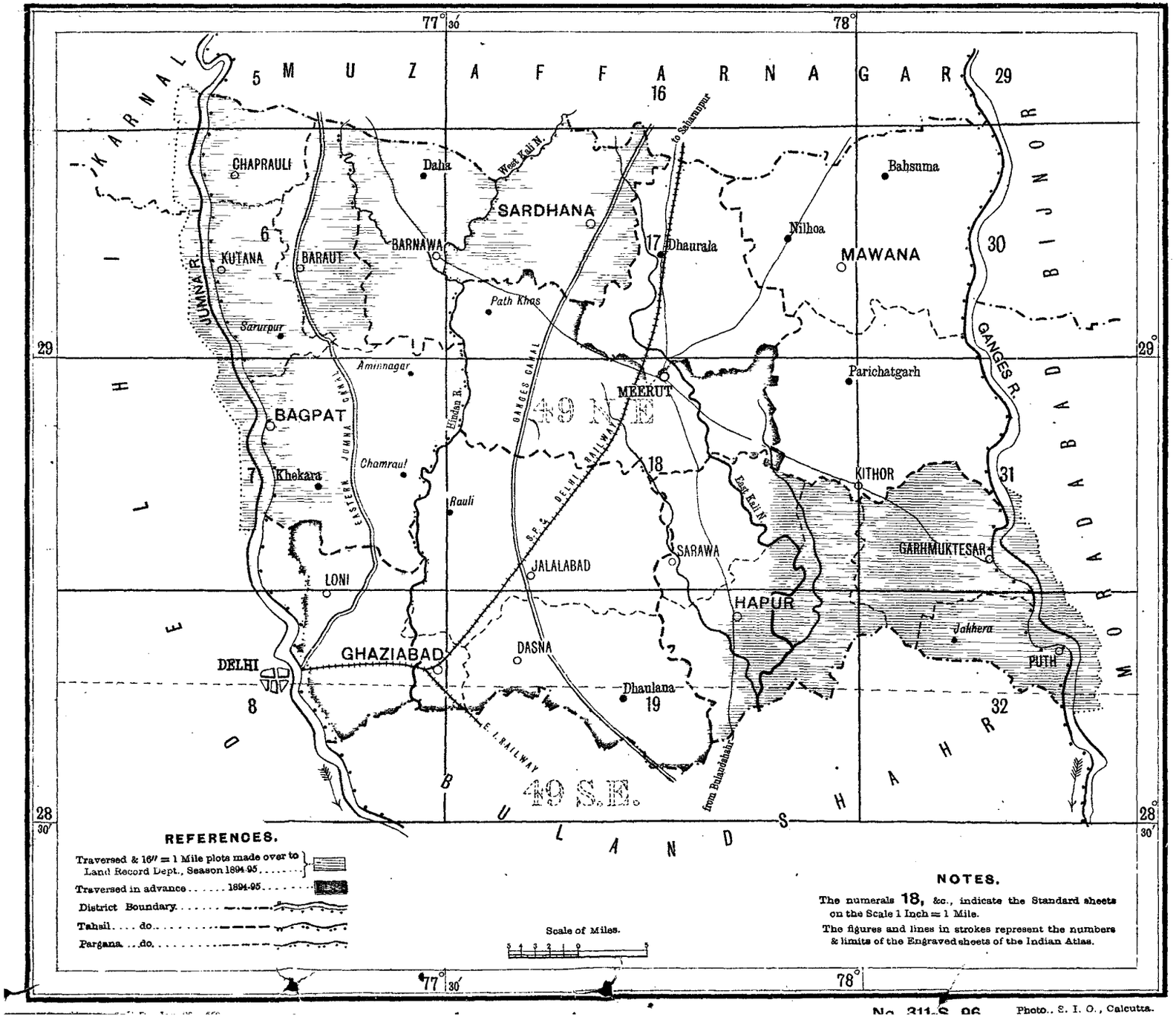
528. The permanent marks used for marking traverse stations in both districts were of three descriptions, *viz.*, stones with dressed triangular prism heads, glazed cylinders, and locally-made baked clay cylinders. The first were used only for marking, in some instances one, and in others two out of the three stations next to tri-junction platforms of villages; glazed cylinders supplied by Burn and Co., of Ranigunj, marked village boundary stations, and local cylinders were used for sub-traverse stations. The following numbers of marks were embedded :—

	Meerut.	Bahraich.
Stones	3,400	3,825
Pottery cylinders (glazed)	2,000	950
Ditto (locally made) . . .	16,726	17,071

N. W. P. & OUDH SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT MEERUT.

1894-95. DETACHMENT.



REFERENCES.

Traversed & 16" = 1 Mile plots made over to Land Record Dept., Season 1894-95

Traversed in advance 1894-95

District Boundary

Tahsil .... do.

Pargana ... do.

Scale of Miles.

NOTES.

The numerals **18**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

No. 311 S. 96 Photo., S. I. O., Calcutta.

529. The river area in Meerut includes all the country lying within the high banks on either side of the Jumna and Ganges bordering on the season's work, excepting only that portion which runs along the Gaziabad Tahsil, which is not to be cadastrally surveyed till next season. Hence a village area of 15 square miles approximately has been left untraversed, to avoid a re-survey in the event of stations being washed away, which would have certainly occurred before the cadastral survey could follow.

530. Particulars of the work done in each district will now be reported on separately.

Survey of the Meerut District.

531. Tahsils Bagpat, Sardhana, and Hapar, with an aggregate area of 1,062 square miles, being the first in order in which the term of the last settlement would expire, were, in compliance with the wishes of the Director of Land Records, first taken in hand. That officer required that a plot of at least one village in each *patwári's* circle, of which there were no less than 305, should be furnished with the least possible delay, with a view to provide work for all the *patwáris* in the above area. To meet this requirement, the usual system of village survey in compact blocks had, for a time at least, to be abandoned, and a series of traverses, based on either main or sub-circuits, and skirting the boundaries of *patwári* circles, were run instead; the survey of one village in each circle was thus at once made possible. This plan, however, though it suited the Director's requirements, was the cause of considerable delay and trouble to the traverse surveyors.

532. The supply of 16-inch plots to the Settlement Department in the Meerut district was commenced on the 1st January 1895 and kept up regularly, in weekly instalments, throughout the remainder of the field season; at the close of which 706 villages and 15 river blocks, on 1,489 sheets, had been supplied, leaving only 1 village and 2 river blocks to complete the area included in the season's cadastral survey. These were completed and made over by 7th June.

533. The area traversed in advance of the season's cadastral survey was 666 square miles, *viz.*, in *parganas* Jalalabad, Dasna, and Loni, of *tahsil* Gaziabad, 454 square miles, and in *pargana* Meerut, of *tahsil* Meerut, 212 square miles. The 16-inch plots of 335 villages on 519 sheets, with their 4-inch plots of *tahsil* Gaziabad, were made over to the Settlement Department by the 23rd September. Forty villages which need revision will be submitted during November and December next.

534. Azimuth observations were taken at 81 theodolite stations, three or more stars being observed at every station of observation on both faces of the instrument. The mean variation of the magnetic needle was found to be $2^{\circ}\ 32'$ east.

535. Six principal and one secondary station of the Great Trigonometrical Survey of the Great Arc Meridional series have been connected with the traverses. A comparison of direct distances as obtained from Great Trigonometrical Survey data and from uncorrected traverses shows an average error of 8·84 feet per mile.

536. The *parganas* remaining for survey in Meerut are about half of *pargana* Meerut, approximate area 165 square miles; the entire *parganas* of Mowana and Kithor, 236 square miles and 196 square miles, respectively, and 15 square miles in *pargana* Loni, *tahsil* Ghaziabad. These will all be completed during the next season.

537. The demarcation of boundaries where attempted at all was carried out in a most perfunctory manner. A few clods of earth, scarcely distinguishable, and these only here and there, were all that indicated the run of boundaries. Even tri-junction platforms were, in the majority of cases, not in existence at time of survey, and were built either during the course of the survey or subsequent to it.

Survey of the Bahraich District.

538. In accordance with instructions, *parganas* Bahraich, Hisampur, and Ikauna were first brought under survey. These three *parganas* cover an area of about 900 square miles. The Superintendent, Land Records Surveys, visited the camp early in April and issued instructions that work should be

taken up in all the remaining *parganas*, to give employment to the *patwâris* of the several circles. Steps were taken to meet his wishes as far as practicable. About half of *pargana* Nanpara, area 250 square miles, 60 square miles in *pargana* Bhinga, 25 square miles in *pargana* Charda, and about 77 square miles in *pargana* Fakharpur were surveyed. In *parganas* Tulsipur and Gharampur, which touch on Nepal to the west and east, nothing could be done for want of available hands.

539. The work in *pargana* Bahraich was started on needle bearings. The number of azimuths observed was 85. The variation of the needle is 2° 31′ east.

540. Six Great Trigonometrical stations of the East Longitudinal series were connected with, also twenty conspicuous objects other than Great Trigonometrical stations, and their co-ordinate values are given. These have all been plotted on the 16-inch skeleton sheets.

541. The *parganas* remaining for survey, which will be completed next season, are—

Pargana.	Approximate area in square miles.	Remarks.
Tulsipur	104	
Bhinga (portion of)	121	Exclusive of forest area.
Chorda (ditto)	164	Ditto.
Nanpara (ditto)	246	Ditto.
Dharampur	150	Ditto.
Fakharpur (portion of)	339	

542. The work of the camps, both at Meerut and Bahraich, was frequently inspected by Mr. G. B. Scott, Superintendent, Land Records Surveys.*

GEODETIC.

LONGITUDE OPERATIONS.

Nos. 22 and 23 Parties, Astronomical.

543. The Astronomical parties, Nos. 22 and 23, were engaged in combination throughout the year, in the electro-telegraphic determination of the difference of longitude between Greenwich and Karachi.

Personnel.

No. 22 Party (Astronomical I).

Captain S. G. Burrard, R.E., Deputy Superintendent, 1st grade, in charge.
Munshi Aulad Hussein, Sub-Assistant Superintendent, 2nd grade.

No. 23 Party (Astronomical II).

Captain G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 2nd grade, in charge.
Babu Hanuman Prasad, computer.

544. The present values of the longitudes of the principal triangulation throughout India are based on a telegraphic determination of difference of longitude between Bombay and Greenwich. The determination was the result of the combination of two entirely separate operations. For the purposes of the Transit of Venus Expedition in 1874 the difference of longitude between Greenwich and Suez was determined by the astronomers of the expedition, and in the year 1877 Captains Campbell and Heaviside of the Survey of India, in continuation of previous electro-telegraphic determinations of difference of longitude executed in India, were employed to ascertain the difference of longitude between Bombay, Aden, and Suez. The large transit instrument and the chronographs which have been used throughout the Indian longitude work were employed by them, the system of work being modified to suit the necessities of signalling by cable.

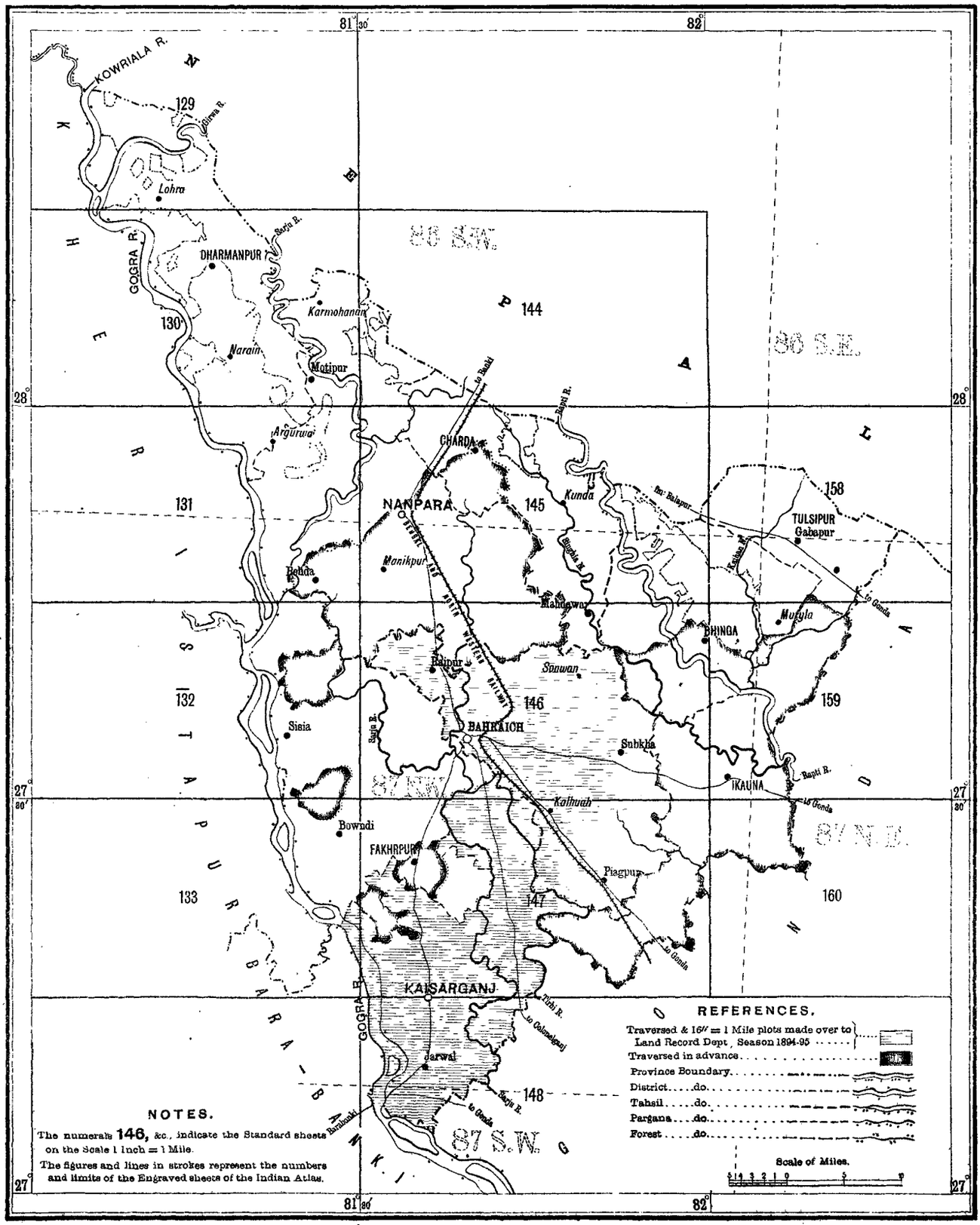
* Mr. Pemberton reports that Mr. W. J. O'Sullivan, who had charge of the Bahraich section, conducted all his duties most ably and satisfactorily. Mr. G. E. Parker was employed throughout in office and rendered much assistance. Mr. G. Rae is said to be intelligent, willing, and hard-working, and especially careful incarrying out orders.

The following members of the native establishment are selected for special mention:—Latifullah Khan, Dharonidhar Mukerjee, Gouri Shanker, Ram Lochan Lal, Niaz Mahomed Khan, Kannahya Lal, and Mumtaz Ali.

N. W. P. & OUDH SURVEY (TRAVERSE).

INDEX TO THE SURVEY OPERATIONS IN DISTRICT BAHRAICH.

1894-95. DETACHMENT.



Reg No. 475, S I D.—Jan. 96.—550.

Photo., S. I. O., Calcutta.

No. 313-S. 96.

545. With the possible exception perhaps that the determinations of personal equation between the observers may not have been quite as full as advisable, the determination of the differences of longitude on this section, *i.e.*, Bombay-Suez, are probably as good as it was possible to arrive at, with the signalling apparatus then available.

546. The section, Suez-Greenwich, however, stands on a somewhat different footing. The observations were taken for the determination of positions for Transit of Venus purposes, and were not executed with such refinements or precautions as are necessary for the determination of fundamental longitudes.

547. As a check on the determination of longitude *viâ* Suez it was therefore determined to carry out a second line of determinations *viâ* the Indo-European telegraph line through Persia. As this would entail the transport of the instruments by mule carriage, it was considered advisable to reduce the size of the transit instruments so as to lessen the danger of accident to them. Two new transit instruments were therefore ordered from Messrs. Troughton and Simms. These have an aperture of $3\frac{1}{2}$ inches and a focal length of about three feet. Though by no means so powerful as the instrument previously used, they are excellently made and the facility with which they can be reversed in their bearings will no doubt add to the accuracy of the work executed with them.

548. As the chronographs and clocks which formed part of the original longitude equipment had been in almost constant use for the last twenty-three years, it was determined to renew them, and two new chronographs were obtained from Messrs. Warner and Swasey of the United States and two break circuit chronometers from Messrs. Bond, also of America. The chronographs differ from those previously used, in having one recording pen instead of two, and have an entirely different governor system for regulating the rate of revolution. They are very simple and strong and give most excellent results.

549. The programme of operations at first decided upon was to commence operations at Karachi and to determine a series of longitudinal arcs in succession westwards to Greenwich. It was found necessary to modify this subsequently.

550. After some preliminary experiments with the new equipment at Dehra Dun in October 1894, Captain Burrard, R.E., and Captain Lenox-Conyngham, R.E., who were in executive charge of the operations, left for Karachi in November 1894.

551. The first arc measured was from Jask to Bushire. Considerable difficulty was experienced owing to our electrical apparatus not having been designed for work through cables; but through the kindness of the telegraph officials Captain Burrard was able to borrow more delicate relays and re-model his electrical arrangements, so that the work was satisfactorily accomplished.

552. As it was considered very advisable for geographical purposes to ascertain the longitude of Charbar on the Makran coast, it was arranged that Captain Conyngham should now proceed from Bushire to that place, Captain Burrard moving to Karachi. Through the kindness of Mr. Possman, the Director of Persian Gulf Telegraphs, Captain Conyngham was given a passage in the telegraph steamer "*Patrick Stewart*." This was very convenient, as it is difficult to arrange for the ordinary steamers to stop at Charbar. As the landing at that place was known to be a matter of difficulty, it was determined to leave the transit instrument and chronograph behind at Jask, and that Captain Conyngham should take only the zenith telescope with him to Charbar, thus avoiding the risk of landing the heavy instruments. The longitude was fixed with quite sufficient accuracy for the purpose required by observing the transits of stars with the zenith telescope at Charbar and recording the transits through the telegraph line on the chronograph sheet at Karachi; the retardation of the current being separately measured and allowed for. Captain Conyngham also observed a latitude and an azimuth at Charbar.

553. Returning to Jask Captain Conyngham measured with Captain Burrard the arc Karachi-Jask and subsequently the arc Bushire-Karachi, thus completing a circuit. Both observers subsequently met at Karachi for the purpose of determining their personal equation.

554. It was now settled to change the subsequent procedure as laid down in the original programme, and that both observers with their equipment should proceed to England, whence arrangements for the remainder of the work could

more readily be made. Captains Burrard and Conyngham accordingly reached England in April. Considerable delay was experienced before work could be recommenced, as arrangements had to be made with continental Governments, through the Foreign Office, for the use of the telegraphic wires and other needful assistance. Even when work was commenced on the arc Greenwich-Potsdam great delay was caused by constant cloudy weather. The arc was, however, satisfactorily completed and arrangements at once commenced for the determination of the longitudinal arc Potsdam-Teheran. It is hoped that this will be measured by the end of October.

555. There will then only remain the arc Teheran-Bushire to complete the last link in the chain of longitudes, and it is expected that the whole of the observing work will be finished by March 1896. The reduction and computation of the work will probably be completed by next September.

556. The department is greatly indebted to the Astronomer Royal, Mr. Christie, for his cordial co-operation in the work at Greenwich and Captain Burrard speaks warmly of the ready help and advice afforded to him by the German officials at Potsdam.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

557. The direction of these operations was in the hands of Colonel J. Hill, R.E., until he proceeded on six months' special leave on the 6th April 1895. From that date the operations were in charge of Lieutenant Morice, R.E., but he was granted 1 month and 22 days' privilege leave at the end of the recess, and during his absence the operations were under the superintendence of Mr. G. Belcham. Colonel Hill was promoted by Brevet to the rank of Colonel on the 1st August 1895.

Personnel.

Colonel J. Hill, R.E., Superintendent, 2nd grade, in charge up to 6th April 1895.
Lieutenant C. C. D. Morice, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 6th April 1895 up to 9th August 1895.
Mr. G. Belcham, Extra Assistant Superintendent, 2nd grade, in charge from 9th August 1895.
„ E. J. Connor, Extra Assistant Superintendent, 4th grade.
„ J. Bond, Extra Assistant Superintendent, 4th grade.

Surveyors, etc.

Dhondu Vinayek, Vinayek Narayen, N. V. Apte, 2 native mechanics and 14 recorders and computers.

Tidal Operations.

558. The automatic recording of the tidal curves, their reduction and the publication of the predicted times and heights of high and low water have been continued, and tidal observations by means of self-registering gauges have been carried on during the year at thirteen stations, *viz.*:—*Aden*, Maskat, Bushire, *Karachi*, *Apollo Bandar (Bombay)*, Prince's Dock (Bombay), Minicoy, Trincomalee, *Madras*, *Kidderpore*, Diamond Island, *Rangoon*, and *Port Blair*. The six tidal stations, whose names are not italicised, are minor stations, where observations, as a rule, are taken for five years only. The others are permanent stations, where the minimum period of observations lasts for 19 years, and where observations should be continued until the whole scheme of tidal operations has been completed. In addition to the observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily, with the object of comparing the actual heights and times of high and low water with those predicted in the tide-tables at the following tidal stations, at all of which the tidal observatories are closed:—

Bnávnagar, Cochin, Tuticorin, Colombo, Chittagong, Akyab, Moulmein.

559. No tidal observatories were closed during the year.

560. The permanent observations at Madras were resumed in November 1894, and the minor station at Diamond Island (Burma) was established in December 1894. Detailed descriptions of the observatories are given in the appendix.

561. Thus, since the resumption of systematic tidal operations in 1877, observations have been taken at 34 tidal observatories, of which 21 have been closed on completion of their registrations and 13 are now in operation.

562. During the survey year 1895-96 the observatories at Minicoy and Trincomalee will be closed on completion of five years' observations at those stations. The establishment of a minor tidal observatory at Perim has been sanctioned, supposing a suitable site to be found. Perim will be visited and arrangements made for the observations. The examination will also be undertaken of four other intended stations, namely, Mangalore, Porbandar or some other suitable port on the west coast, north of Bombay, and two places, one on each side of the isthmus of Kra. The light-house at Port Albert Victor, Bhávnagar, is not likely to be ready to receive the tidal instruments during 1895-96.

563. All the tidal observatories, with the exception of Bushire and Minicoy, have been inspected. It was not convenient to carry out the intended inspections of these stations, which came towards the end of the field season's programme, because the inspection detachment occupied on the western side of India was at Maskat during the rebellion that occurred there in February, and it became necessary owing to the illness of some of its members to reduce its programme by leaving out these two items. Neither station, however, particularly needed inspection, and both will be visited early this field season. A detailed account of the working of each observatory will be found in the appendix, where also certain circumstances deserving special notice are reported at Aden, Maskat, Bushire, Prince's Dock (Bombay), Minicoy, Trincomalee, Madras, Kidderpore, Diamond Island, Rangoon, and Port Blair. No serious interruption of observations occurred at any tidal station.

The tidal operations of the year may be pronounced very successful, a result due to a great extent to the assistance received from local officials, whose kind co-operation has been acknowledged by Lieutenant Morice. Special thanks are due to Mr. Alfred Lee Pogson, Engineer to the Harbour Trust Board of Madras, for invaluable co-operation in arranging for, designing, and preparing, the new observatory there, and assistance of every kind in the starting of the observations and their supervision: also to Mr. D. Joscelyne, Superintending Engineer, First Circle, Rangoon, and to Mr. T. Harman Tyndall, Executive Engineer, Bassein Division, for similar co-operation in connection with Diamond Island (Burma).

564. Colonel Hill completed and submitted for publication early in April a "Chart (on Mercator's Projection) of the Tidal and Levelling Operations of the Survey of India Department, 1858—1895, showing approximate co-tidal lines," which he reported in the last two annual reports that he was preparing. It gives full information on the following subjects: the course and dates of execution of the great lines of levelling from their very commencement up to 1895; the tidal stations, permanent and minor, and the dates during which they have been in operation; the ranges of tides and establishments of the ports, determined by the Department at the tidal stations, and by other accepted authorities there and elsewhere; and approximate co-tidal lines for all Indian waters, which it is thought must be an advance on anything of the kind produced hitherto, on account of the precision of the statistics evaluated at the tidal stations and the mass of compiled information utilised. Details of the manner in which the chart was prepared are given in the appendix and particulars of the authorities on which it is based. Sixty photo-zincographed copies of the chart on a scale large enough to show details clearly, but not inconveniently large, have been prepared and will be distributed to persons interested in and assisting the operations. It is intended to have the chart ultimately engraved.

565. Good progress has been made in the testing of the new method of reducing tidal observations, invented by Professor G. H. Darwin, which Colonel Hill reported last year that he was carrying out in conjunction with the inventor and Mr. E. Roberts of the Nautical Almanac Office. The general accuracy of the method seems very good. But it is a difficult matter, involving heavy test calculations, to make certain that it is practically as accurate as

the method now in use, and it would, owing to various special reasons, be very difficult and expensive to introduce it and utilize it in India; and the inconvenience from the dissimilarity of previous and subsequent records would be very serious. Full details regarding the matter are given in the appendix.

566. A practical difficulty has arisen in the application of the principle laid down in or shortly prior to 1885 by Professor Darwin, Major (now Colonel) Baird, R.E., and Captain Wharton, R.N., that the scientific datum called "Indian Spring Low-water Mark" should be adopted for charts of Indian waters. The datum-line depends upon mean sea-level, and it is now apparent that mean sea-level cannot be certainly determined in Indian waters from tidal observations extending over short periods, such as two or three lunations or, indeed, less than a year. Consequently, it is impossible to bring the datum into general use for charts. This question is fully entered into and the work done in connection with it is particularized in the appendix. It is there shown that in Indian waters it is equally safe to adhere to formerly accepted datum-lines, such as "the mean level of low water ordinary spring tides," so that practially the matter is not of great importance. In this connection the investigations which will now be mentioned proved very useful.

567. The question of the variation of the mean sea-level from time to time during the year, which was reported as being under investigation last year, has been examined at almost all the tidal stations past and present. The precise values of the monthly mean sea-levels at thirty-four tidal stations have been computed and tabulated for the full period possible in each case up to the end of 1893. Two specimen tables are given in the appendix and the whole are preserved in the office of the tidal operations for reference. The tables prove that the mean sea-level varies as much as a foot-and-a-half at many open coast stations and several feet at some riverain stations in different months and also differs largely in the same month in different years. Much that is interesting turns on this question and a few important considerations are brought to notice in the appendix.

568. The question of the reliance to be placed upon the meteorological observations taken at the tidal observatories was summed up by Colonel Hill last year (p. xl, appendix to General Report, 1893-94). It seems possible to arrive at an estimate of the value of the observations, even from the commencement of the work (since many of the instruments used at that time are still in use) by a system of comparison with standard instruments kept at Poona, and in the case of thermometers by test-comparisons of two or more kept in each observatory. Steps are being taken in this direction.

569. The reduction of the tidal observations has been carried on steadily during the year. Observations for one year at eleven tidal stations have been reduced: the tabulated values of the constants so obtained will be found in the appendix. The computations for each tidal observatory commence now, as a rule, on January 1st. In addition to the constants mentioned above, constants to be employed in setting the tide-predictor were calculated for the year 1896 and sent to Mr. Roberts of the Nautical Almanac Office ready for use: he was also furnished with tabulated comparisons for the year 1894 between the predicted times and heights of high and low-water at eighteen stations, published in the tide tables for that year, and their values obtained by actual measurement, thus giving him in a convenient form information adapted to assist him in improving subsequent predictions, especially at the three principal riverain ports—Kidderpore, Rangoon, and Moulmein.

570. The tide tables again arrived from London over a month too late to admit of their being distributed to the several ports before the beginning of the year 1895 for which they predicted the tides. It is pointed out that the Surveyor-General and Deputy Surveyor-General have expressed the opinion that a change in the manner of issuing the tide tables was desirable. A reference is invited to Colonel Hill's report on the subject last year; and his suggestion that the intervention of the India Store Department, to which the delay appears to be due, should be dispensed with, and the tide tables forwarded direct by Mr. Roberts to the office of the operations is again advanced as the remedy.

571. The tide tables for 1896 will contain predictions for thirty-five tidal stations.

572. The usual tables showing the results of the predictions are given for the year 1894 in the appendix, and may be summarized as follows:—

Percentage of time predictions within fifteen minutes of actuals.

							High water, per cent.	Low water, per cent.
Open coast stations	10	at which predictions were tested by				S.R. tide-gauge	65	62
	4	„	„	„	„	tide-pole	72	67
Riverain stations	2	„	„	„	„	S.R. tide-gauge	56	55
	2	„	„	„	„	tide-pole	77	70

Percentage of height predictions within eight inches of actuals.

							High water, per cent.	Low water, per cent.
Open coast stations	10	at which predictions were tested by				S.R. tide-gauge	95	92
	4	„	„	„	„	tide-pole	100	100
Riverain stations	2	„	„	„	„	S.R. tide-gauge	66	42
	2	„	„	„	„	tide-pole	61	65

Percentage of height predictions agreeing within one-tenth of mean range at springs.

							High water, per cent.	Low water, per cent.
Open coast stations	10	at which predictions were tested by				S.R. tide-gauge	97	95
	4	„	„	„	„	tide-pole	91	93
Riverain stations	2	„	„	„	„	S.R. tide-gauge	88	80
	2	„	„	„	„	tide-pole	86	84

In this summary, as explained in the appendix, the tests by self-registering tide gauges are the more reliable, especially with regard to time. Subject to this consideration the predictions for time, although not equal to those for height, are undoubtedly very good: and the figures as a whole show a high standard of accuracy.

Spirit-Levelling Operations.

573. The regular levelling operations were carried out by Mr. J. Bond. The first work to be done was the connection of the standard bench-mark for Calcutta with the Kidderpore tidal observatory and with the spirit-levelling executed in 1882-83. The distance levelled over exceeded six miles, in the course of which two existing embedded bench-marks, four bench-marks of reference of the Kidderpore tidal observatory, five existing inscribed bench-marks, eight new inscribed bench-marks, and the standard bench-mark for Calcutta were connected.

574. The remaining and much more extensive work was the continuation of the line of double-levelling executed in field season 1893-94; the work was carried from Cuttack down the coast *viâ* Khurda and Ganjam to Berhampur and thence along the open line of the East Coast Railway to Vizagapatam, closing on the bench-marks of reference of the Vizagapatam tidal observatory; thus effecting a connection with the spirit-levelling that was brought northwards to Vizagapatam in 1887-88 and completing the junction by spirit-levelling of all the tidal stations along the Eastern Coast of India. In connection with this a branch line, forty miles long, was carried from Khurda along the high road to Jatni railway station and thence to Puri, to form a basis for the rectification of the railway levels and to determine the height of points in Puri. The levelling was carried over fairly level country till it reached the hills between the Bengal and Madras Presidencies: here the ground was very steep, some of the country levelled over was rough and covered with jungle; the connection of four Great Trigonometrical Survey stations, each involving a long ascent, added considerably to the task.

The levelling was carried over country, the total rises and falls of which, including the work at Calcutta, amounted to 12,825 feet, and the total outturn to 356½ miles of double-levelling, in the course of which the heights of one standard bench-mark, 37 ordinary embedded bench-marks, 365 ordinary inscribed bench-marks, 7 bench-marks of reference of tidal observatories, 31 railway bench-marks, 5 Public Works Department bench-marks, and 4 stations of the Great Trigonometrical Survey were determined. This is a good outturn and very creditable to Mr. Bond, who carried out his work most efficiently

The highly satisfactory character of the levelling thus completed may be estimated by comparing the height of the closing bench-mark at Vizagapatam, as derived from the tidal observations at that place with its height, as derived from the origin of the line of levels at Cuttack near False Point. The height derived from the origin is only one inch higher than that derived from Vizagapatam and the distance between the points is $365\frac{1}{4}$ miles.

575. During next field season the levelling operations will commence at Raipur on the direct line between Bombay and False Point and be carried southwards to join the past season's levelling near the Vizagapatam tidal station, connecting with trigonometrical stations of the Bilaspur Meridional Series and forming the first instalment of the line between Vizagapatam and Allahabad which is one of the lines named in the outline, given in last year's General Report, of the completion of the general scheme of spirit-levelling operations.

576. In connection with the preservation of the bench-marks, Colonel Hill suggested in his last annual report that it would be advantageous to have a periodical inspection by an officer of the department of the principal marks of reference, such as pillars of the base lines and standard bench-marks and of a proportion of the lesser, though very important, stations and bench-marks of the Great Trigonometrical Survey of India; and he gave striking instances that had recently come under his observation of a large number of important marks that had disappeared. No such remarkable discoveries have been made this year, but the matter cannot cease to demand constant attention.

577. In addition to the regular departmental work of the tidal and levelling party, a very considerable amount of extra work had to be undertaken in order to furnish other departments, Local Governments, scientists, and local officials with information applied for by them, the particulars of which are given in the appendix.

578. The office of this party was inspected in August 1895 by the Surveyor-General.*

GEOGRAPHICAL SURVEYS.

OPERATIONS WITH THE MEKONG MISSION.

579. The survey detachment detailed to accompany the Anglo-French Mission of enquiry into the limits of the proposed Buffer State on the Mekong river was composed of the officers named in the margin.

Personnel.

Colonel R. G. Woodthorpe, C.B., R.E., Superintendent, 2nd grade, in charge.
Lieutenant C. H. D. Ryder, R.E., Assistant Superintendent, 1st grade.
Ramsabad Misser, Sub-surveyor.
Abdul Rahim, Sub-surveyor.
Aminullah, Hospital Assistant.

580. It was arranged that the officers composing the Mission, with the escort, etc., should assemble at Taunggyi early in November 1894. Colonel Woodthorpe, on rejoining from leave, left Calcutta in the S.S. *Purneah* with the Khasia coolies and *khalásis* on the 29th October, and arrived at Meiktila Road on the 3rd November, Lieutenant Ryder having gone on in advance to make preparations for the start. Leaving again on the morning of the 4th, the party reached Taunggyi on the 9th, where they found all the other members of the Mission except the British Commissioner, Mr. J. G. Scott, C.I.E., who was to join the party at Haung Luk or Mong-lin, and Mr. G. C. Sterling, Assistant Commissioner, then *en route* from England.

581. The route adopted by the survey detachment was different from the one taken by the rest of the Mission, as Colonel Woodthorpe was anxious to reach Haung Luk as early as possible in order to continue the triangulation which had ceased at that point last year. The surveyors accordingly proceeded by a more southerly route than the main road through Keng Tung, leaving this road at Keng Hkam and passing through Mong Pu and Mong Hsat. Captain H. B. Walker, D.C.L.I., accompanied the party in order to procure information re-

* Lieutenant Morice reports most favourably of Messrs. Belcham and Connor and Surveyor Dhondu Vinayek in the tidal division and of Mr. Bond and Surveyor Vinayek Narayen in the levelling division. The staff of native mechanics, sub-surveyors, and computers are reported to have worked wel and given satisfaction.

garding the route for the Intelligence Branch. Reaching Keng Hkam on the 19th November a short halt was made, and Sub-Surveyor Abdul Rahim was ordered to proceed to Keng Tung to visit several of last year's stations. Leaving Keng Hkam on the 21st the party arrived at Haung Luk on the 5th December, Lieutenant Ryder having gone on to Loi Paleng, a high point to the north of the road which was to form one of the starting points of the triangulation. On the 5th Colonel Woodthorpe observed to Lieutenant Ryder's and Abdul Rahim's stations, and a very satisfactory commencement was made. Lieutenant Ryder and the sub-surveyor having rejoined, the party went on to Keng Lap, whence Lieutenant Ryder, Captain Walker and Abdul Rahim proceeded to Hpachitive, a conspicuous hill which was to form another principal station, where, however, work was delayed for some days by clouds and rain.

582. Mr. Scott, accompanied by Messrs. Warry and Sterling, and Surgeon-Major Lloyd, arrived at Keng Lap on the 19th December with an escort consisting of 30 men of the 1st Burma Battalion under a native officer. Mong Hsing was reached on the 24th December, and on the following day Captain Walker and Lieutenant Ryder rejoined the party. While waiting for the arrival of the French members of the Mission, visits were made to several high peaks in the neighbourhood of Mong Hsing in order to extend the triangulation, and a good deal of useful work was done.

583. M. Pavie, the French Commissioner, accompanied by Captain Rivière, head of the survey party, Lieutenant Seauve, Topographer, and M. Caillot, Secretary, having arrived on the 1st January 1895, meetings were held to discuss the programme, and the French surveyors were initiated into the methods of the Indian Survey Department. A base line was also measured on the plain to the east of Mong Hsing, and the position of that place and its height trigonometrically determined.

584. Three other French officers, M.M. Lefevre Pontalis, Thomassin, and Dr. LeFevre were expected daily, but as no news of them had been received up to the 10th January, it was agreed to commence operations at once in order not to lose the clear weather, and to make sure of completing the triangulation satisfactorily. Lieutenent Ryder and Captain Rivière accordingly proceeded southwards to connect some of Mr. McCarthy's points with the triangulation and to fill in some blanks in the Keng Kong district and improve the topography of other portions, while Colonel Woodthorpe and Captain Walker visited Loi Hpeleng, a hill on the road from Mong Hsing to the Ban Law ferry. On completing this work he proceeded to Ban Law, where he was rejoined by the two surveyors who had been triangulating and plane-tabling the country round. From this place Ramsabad was sent on another trip to fill in the country between the Mekong and Mong He, and marched with Captain Walker for that place on the 23rd.

585. The English and French members of the Mission eventually met again at Mong He on the 26th January, the remaining French officers having joined in the meantime. On the 29th M. Pavie and Captain Walker, with M. Caillot, left for Mong Yu and Mong Wa. Mr. Scott and the remainder of the party, English and French, remained at Mong He till the 1st February to allow the sepoys' rations to come up. On that date the party left for Mong Hpung *viâ* the Ban Lik ferry. Ramsabad did as much topography as possible *en route*, and ran a careful route traverse, checked by Colonel Woodthorpe, with the subtense and observations for latitude and azimuth. At Mong Hpung, which was reached on the 9th February, a letter was received from Lieutenant Ryder reporting that owing to some misunderstanding between himself and Captain Rivière he had been prevented from working south of the Mong Long Pukha—Keng Kong road. This was at once rectified by M. Pavie, who wrote to Captain Rivière informing him that the restriction only applied to Luang Prabang, not to Keng Kong.

586. From Mong Hpung the English and French members of the Mission separated for a time, the latter going south to Mong Long Pukha, while Mr. Scott's party travelled to that place *viâ* Mong La and Baw Hè in order to ascertain approximately the eastern boundary of the Mong Hsing district. They reached Mong Long Pukha on the 19th February and remained till the 21st February. Here it was arranged that Colonel Woodthorpe, with Captain Walker and Lieutenant Thomassin should proceed southwards to cor-

rect and elaborate the topography of the south-eastern portion of the Keng Kong district, Mr. Scott proceeding westwards to examine the country south of Keng Lap, occupied by some Keng Tung villages. Colonel Woodthorpe managed to get a considerable addition to his plane-table outturn, but the absence of roads, the dense haze, and want of time prevented him from doing as much as he had hoped by the 10th March, when the party marched into Keng Kong where most of the French officers had assembled Mr. Scott did not arrive till the 21st, and from that date till the 3rd April time was occupied in final discussions, preparation of a joint map, etc. On the 3rd April the Mission broke up, and Colonel Woodthorpe and his party arrived at Taunggyi on the 4th May. Thence he proceeded to Mandalay where he prepared a map to accompany Mr. Scott's report on the Mission, which was handed over to that officer at Rangoon in the following month.

587. The survey work done consisted of (1) triangulation, (2) topography, plane-table sketching based on the triangulation, (3) route traverses when the nature of the country, or in February and March the haze, prevented more elaborate survey. The triangulation is an extension of that done during previous seasons, and is based on the G. T. series which Lieutenant Close was able to carry up to within a short distance of Hawng Luk. The whole of the Buffer State was covered with triangulated points, and others were thrown out to the north and north-east, which it is hoped may be of use in any future boundary operations. A very satisfactory junction was also made with Mr. McCarthy's elaborate triangulation of Siam.

588. The area triangulated was 10,712 square miles; that of fairly accurate topography on the scale of 1 inch=4 miles, 4,928 square miles, and of sketching 2,150 square miles. The positions of most of the principal places visited were fixed trigonometrically, and when this was impossible observations for latitude were taken, and the longitude obtained by careful traverses from the nearest triangulated point, or by observation for azimuth to some fixed point.

589. No special fair map is being made to illustrate the labours of the Mission. Two joint tracings were made of the country examined at Keng Kong for Mr. Scott and M. Pavie, and the map already mentioned prepared to illustrate Mr. Scott's report. The fair maps for publication, however, are being drawn in sheets uniform with the other published sheets of the South-East Frontier, and the area examined by the Mission is contained principally in the two sheets, Nos. 13 $\frac{\text{N. W.}}{\text{S. W.}}$

590. Colonel Woodthorpe reports that Lieutenant Ryder proved himself a very valuable assistant. He carried out all the preliminary arrangements for the work at Rangoon and Meiktila Road with the Civil, Military, and Commissariat Officers, so that everything was ready for a start when Colonel Woodthorpe arrived at Meiktila Road. He worked well and with a good deal of judgment throughout, and spared himself neither trouble nor fatigue to make the work a success. He visited and observed at five hill stations and reconnoitred roughly 1,300 square miles of country. *

* Of the sub-surveyors employed with the Mission, Colonel Woodthorpe reports that "Ramsabad worked hard and well, as he always does. He can always be trusted to avoid complications with the natives, and to use his own judgment in deciding how far his work may be carried without prejudicing either his own safety or the objects of the Mission.

"Abdul Rahim has again contributed considerably to the success of the work and especially of the triangulation. His zeal and energy are most praiseworthy."

The hospital assistant Aminullah is also very favourably reported on.

OPERATIONS WITH THE PAMIR BOUNDARY DELIMITATION COMMISSION.

591. A survey detachment was formed in June 1895, under Colonel Holdich, to accompany the Pamir Delimitation Commission.

Personnel.

Colonel T. H. Holdich, C.B., C.I.E., R.E., Superintendent, 1st grade, in charge.
Major R. A. Wahab, R.E., Deputy Superintendent, 1st grade.
Abdul Ghafur Khan Sahib, Surveyor.
Asmatullah Khan, Sub-Surveyor.
Dan Singh, Sub-Surveyor.

592. The objects of the survey were, first to make topographical maps of the country adjoining the boundary, to assist the commissioners in defining it; and, secondly, to effect such a junction with the Russian survey system as would ensure a common basis for the mapping on both sides. Both these objects were satisfactorily accomplished.

593. In order to effect the second of these objects it was decided to carry on a triangulation based on the peaks south of the Hindu Kush and Mustagh ranges, fixed by Colonel Tanner, and on two others fixed by the G. T. secondary triangulation. With great difficulty, owing to most unfavourable weather, a series of triangles was carried from the Darkot pass up the narrow valleys of the Yarkhan and Wakhan rivers eastwards to Bozai Gombaz and the Pamirs. Bases were measured at Zartigar, north of the Baroghil pass, at Langar Sarhad, and at Chakmaktin, on the borders of the lake which is the the source of the Aksu, at an elevation of 13,000 feet above the sea. With the help of these bases and in spite of the inclement weather, the triangulation was pushed on as rapidly as possible to the Benderski pass leading from the Little to the Great Pamir, when a sudden break in the weather put an unexpected end to all difficulties. From a peak near the pass Major Wahab obtained a magnificent view of the whole line of the Himalayas to the south, whilst at the same time he could see northward to the Sarikul and trans-Alai ranges which must be within sight of Osh. He was equally fortunate on two other occasions; it is therefore certain that the basis of the surveys is as sound and reliable as could be expected. Whilst Major Wahab carried on the triangulation, the topography was mapped by Khan Sahib Abdul Ghafur with praiseworthy determination. His difficulties were largely due to the nature of the ranges which intersect the Pamirs and their approaches, partitioning the country into narrow valleys at most a mile or two wide, whilst they themselves form broad intervening flat-backed ridges, of width varying from 10 to 30 miles, with a water-shed obscured and almost lost amidst eternal snows and glaciers which offer no marked peaks for recognition.

594. At the first meeting of the English and Russian surveyors it was arranged that each party should work independently, and that any difficulties found to exist in the mapping at the close of the survey should be adjusted by a joint examination of the ground where such discrepancies occurred; and secondly, in order to secure a permanent common basis, both for the present and any future operations, that two points should be selected for a final comparison of latitude, longitude and altitude by both sides. The points decided on were the first boundary pillar and the *gumbaz* or dome of Kizil Robat, near the point where the demarcation ended. The latitude on the Indian side was determined by triangulation checked by observations to north and south stars, and on the Russian side by astronomical observations only. The longitude depended on the triangulation brought up from India, whilst the Russians determined theirs by chronometric observations from their triangulation. The altitudes were determined on our part by trigonometry and on that of the Russians by barometric observations.

595. Colonel Holdich reports that the results were found to be in close agreement, the difference in latitude being 20 seconds at the starting point and 10 seconds at the closing point, and in longitude only 4 seconds and 6 seconds respectively. As regards altitude also the difference was remarkably slight. Great credit is due to all concerned for having carried such accurate surveys through such a country and in spite of so many difficulties.

596. The results of the operations of the detachment were as follows:—

About 40 well marked points and peaks have been fixed by triangulation, extending from 72° 53′ East longitude to 75° 9′ East longitude and from 38° 14′

North latitude southward to a junction with the Indian survey. These points will serve hereafter for the purpose of a junction with the Russian system. The area surveyed in detail on the ¼-inch scale amounted to about 4,806 square miles, and about 250 square miles were specially surveyed on the ½-inch scale to illustrate doubtful or disputed points.*

OPERATIONS WITH THE CHITRAL RELIEF FORCE.

597. A small detachment was organised in April 1895, under Captain Bythell, R.E., to accompany the Chitral Relief Force.

Personnel.

Captain W. J. Bythell, R.E., Deputy Superintendent, 2nd grade, in charge.
Mr. C. George, Sub-Assistant Superintendent, 1st grade.
Hira Singh, Rai Bahadur, Sub-Assistant Superintendent, 2nd grade.
Asghar Ali Beg, Surveyor.
Muhammad Ali, Sub-Surveyor.

598. The party left Nowshera on the 4th April and commenced work at Jalala on the 5th. Large scale plans of the Malakand and Khar camps were made for the General Officers Commanding 3rd and 1st Brigades respectively. At Khar the detachment was divided, Captain Bythell, with Hira Singh and Asghar Ali, undertaking the topography, and Mr. George the triangulation, which it was intended to carry from the base Takt-i-Bahi-Karamar as far as the Laorai pass, and if possible to Chitral. Muhammad Ali was detailed to commence a survey on the ½-inch scale of the Swat Valley.

599. Captain Bythell left Khar on the 13th April and joined the Divisional Head Quarters at Mundah on the 18th, proceeding with it to Dir, and carrying on the ¼-inch detail survey *en route*, assisted by Hira Singh. By the 7th May the topography had been carried as far as the Laorai pass. As it was impossible to continue plane-tabling any further owing to the lack of fixed points to the north-west and west, Captain Bythell determined to run a theodolite traverse from the Laorai pass to Chitral. The traverse was continued successfully and eventually closed on Chitral fort, and was afterwards used as a base for the 1-inch scale survey of the Chitral Valley and the country between Ashreth *nala* and the Laorai pass. The area thus surveyed was 400 odd square miles.

600. Early in August Captain Bythell received orders to join a reconnaissance to Arnawai. He accordingly continued the traverse from one of his stations on the Chitral river for some distance along the Arnawai *nala*, but was obliged to abandon it owing to the difficult nature of the country. He, however, was able to carry a compass traverse to the Zakhanna pass. The results of the reconnaissance were—

(1) Continuation of the Chitral river traverse from Mirkanni to Arnawai, thus completing an unbroken traverse of that river from Chitral to Arnawai.
(2) An accurate traverse of the Arnawai *nala* for 9½ miles from its junction with the Chitral river.
(3) Fairly accurate fixings of the following villages:—Arnawai, Lambabat and Mirkanni, on the Chitral river, Damer or Gud, in the Gud Gol, and Ramram and Kamsai in the Arnawai stream.

Also fixings of points on the Bashgol *nala* watershed, mouth of Bashgol stream and of points on both watersheds of the Arnawai stream. The interior detail of the country between the ridge west of the Ashreth *nala* and the Chitral river between Mirkanni and Arnawai was also roughly secured, as far as regards main spurs and drainage.

601. Mr. George completed the triangulation between the Malakand and Janbatai passes, and afterwards carried it from the Malakand to the base near Hoti Mardan. This was a work of some difficulty, owing to the heat and haze. He had completed this work by the 3rd July, and as the detachment was sufficiently strong without him, he was allowed to return to India.

* Colonel Holdich speaks in high terms of the services rendered by Surveyor Abdul Ghafur, Khan Sahib, whose determination and perseverance will, he trusts, be adequately appreciated and recognised. Sub-surveyors Asmatullah Khan and Dan Singh are also said to have done excellently well. Both men possess exceptional abilities and are strongly recommended for an increase of pay.

THE MALAKAND PASS FROM NEAR DARGAI CAMP, LOOKING NORTH.

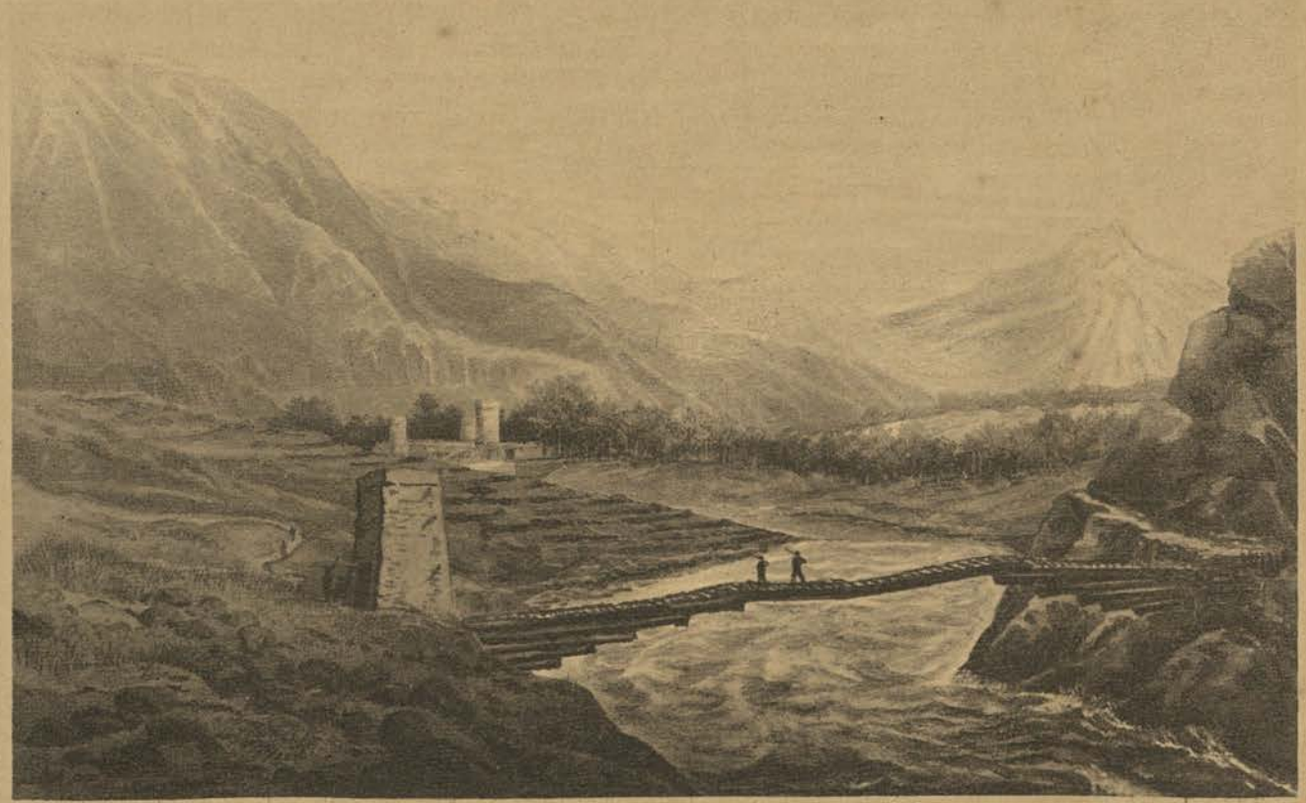


Photo-etching.

Survey of India Offices, Calcutta, February 1896.

CHITRAL BRIDGE AND FORT, LOOKING SOUTH.

From Water-colour drawings by Major W. J. Bythell, R.E.

602. The results of the operations were as follows:—

A series of triangles has been run between Hoti Mardan and the Laorai pass, comprising 29 stations of observations and 53 intersected points, and covering an area of over 1,600 square miles.

The area surveyed in detail amounted to 40 square miles on the 4-inch scale, 450 square miles on the 1-inch scale, 215 square miles on the $\frac{1}{2}$-inch scale, and, approximately, 1,900 square miles on the $\frac{1}{4}$-inch scale.

The distance traversed was 90 linear miles.

In addition, large scale plans of the following camps were made, *viz.*, Malakand, Khar and Naya Kila, Serai, Mundah, Dir and Drost.

The total results, including the work of men attached to the Intelligence Branch (which lies on the east and west flanks of that done by the Survey detachment) may be said to be that considerable knowledge of the topography has been gained of an area of some 3,600 square miles of a country hitherto practically unknown, and much credit is due to Captain Bythell and the men who served under him for so satisfactory an outturn.

603. The annexed views, representing the Malakand Pass and the Chitral bridge and fort, have been reproduced by heliogravure from water colour drawings made by Captain Bythell to illustrate his report.*

* Captain Bythell reports that he has every reason to be satisfied with the work of his assistants.

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of field operations.		TRIANGULATION.									SPIRIT-LEVELLING OPERATIONS.		
				Instrument used.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
Inches to a mile.															
64	2 & 8	Tikari Town	...	...	...	...	...	...	...	...	...	...	...	...	...
	4 & 5	Muzaffarpur Town	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTALS	...	...	...	...	...	...	...	...	...	...	...	...	...
32	2 & 8	Gaya	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Hailakandi Town	5	...	...	...	...	...	...	...	...	...	...	...	...
		Dhubri Town	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTALS	...	...	...	...	...	...	...	...	...	...	...	...	...
27	4 & 5	Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...
16	2 & 8	Darjeeling	...	...	...	...	...	...	...	...	...	...	...	...	...
		Singhbhum	10	...	...	...	...	...	...	...	...	...	...	...	...
		Palamau	...	...	...	...	...	...	...	...	...	...	...	...	...
		Gaya	...	...	...	...	...	...	...	...	...	...	...	...	...
		Patna	...	...	...	...	...	...	...	...	...	...	...	...	...
		24-Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...
		Khulna	15	...	...	...	...	...	...	...	...	...	...	...	...
	3	Meiktila	...	...	...	...	...	...	...	...	...	...	...	...	...
		Yamethin	...	...	...	...	...	...	...	...	...	...	...	...	...
		Yeu and Shwebo	...	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Chindwin	...	...	...	...	...	...	...	...	...	...	...	...	...
		Katha	20	...	...	...	...	...	...	...	...	...	...	...	...
	4 & 5	Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...
		Champaran	...	...	...	...	...	...	...	...	...	...	...	...	...
		Saran	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Cachar	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sylhet	25	...	...	...	...	...	...	...	...	...	...	...	...
	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...
		Thaton	...	...	...	...	...	...	...	...	...	...	...	...	...
		Pegu	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	Raipur	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chanda	30	...	...	...	...	...	...	...	...	...	...	...	...
		Sambalpur	...	...	...	...	...	...	...	...	...	...	...	...	...
		Hoshangabad	...	...	...	...	...	...	...	...	...	...	...	...	...
		Nimar	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bilaspur	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Magwe	35	...	...	...	...	...	...	...	...	...	...	...	...
		Myingyan	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Cuttack	...	...	...	...	...	...	...	...	...	...	...	...	...
		Balasore	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Meerut	40	...	...	...	...	...	...	...	...	...	...	...	...
		Bahraich	...	...	...	...	...	...	...	...	...	...	...	...	...
	F. Brch.	Central Provinces (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTALS	43	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1894-95.

	TRAVERSING.				DETAIL SURVEY.						Remarks.
	Area in square miles.	Stations at which theodolite was set up.	Angular error per station in seconds.	Linear error per *mile*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Fields.	Average size of fields in acres.	
...	...	...	...	...	1	...	...	...	...	...	(*a*) Revision of a previous survey. Includes 3 square miles of village boundary survey.
...	...	...	...	...	2	...	...	...	...	0·04	(*b*) Revision of a previous survey.
...	...	...	...	...	3	...	...	...	...	...	(*c*) Includes 20 square miles of village boundary survey.
...	...	...	...	...	5(*a*)	...	...	8	2,754	0·78	(*d*) Includes 410 square miles of revision survey.
5	0·46	17	12	...	...	...	...	...	...	...	(*e*) Examined with 4-inch survey, and compared with Settlement Department 16-inch village maps.
...	0·25	27	4	...	...	...	...	...	...	...	
...	0·71	44	...	...	415	...	...	658	766,795	...	
...	...	...	...	...	14 (*b*)	...	...	8	22,247	0·44	
...	155	4,004	...	...	210	...	833	...	108,750	1·23	
10	1,175	26,456	...	...	...	...	...	...	...	...	
...	5	233	...	...	162	...	384	181	66,352	0·82	
...	117	4,422	...	...	120(*c*)	...	...	138	71,700	0·78	
...	18	637	...	...	6	...	...	8	10,173	0·69	
...	0·50	9	...	...	3	...	66	53	62,129	0·35	
15	20	590	...	...	20	...	42	8	4,376	2·93	
...	...	...	...	...	95	...	146	95	22,253	2·70	
...	815	23,357	6·5	0 45	1,002	...	1,503	932	485,872	1·30	
...	507	8,502	8	0·70	239	...	...	72	77,245	2·13	
...	178	4,613	...	0·39	150	...	...	254	233,792	0·37	
20	115	6,010	7	0·35	163	...	...	135	114,764	0·90	
...	...	...	...	...	1,068(*d*)	...	2,605	1,314	1,696,935	0·44	
...	126	2,795	...	...	1,162	...	4,929	1,038	1,341,030	0·56	
...	516	18,203	...	...	...	...	...	...	...	...	
...	511	14,378	5	1·00	540	...	1,773	474	220,367	1·57	
25	0·06	24	7	...	0·06	...	...	1	2	20·18	
...	325	3,419	5	0·06	611	...	1,159	233	161,415	0·34	
...	432	15,951	5	0·08	423	...	1,693	323	207,229	0·90	
...	247	3,927	5	0·04	...	...	...	...	...	...	
...	489	...	2·5	1·10	...	...	...	...	...	...	
30	719	...	2·9	0·90	...	...	...	...	...	...	
...	528	...	1·4	0·50	...	...	...	...	...	...	
...	29	32,033	4·6	0·80	...	...	...	...	...	...	
...	81	...	0·7	0·10	...	...	...	...	...	...	
...	46	...	5·8	0·70	...	...	...	...	...	...	
35	3	40	...	...	897	...	2,353	882	222,108	2·58	
...	905	14,207	5	2·77	8			3	2,128	2·42	
...	...	...	...	...	24	251	33	...	...	...	
...	...	...	...	...	5	...	39	43	8,988	0·36	
...	...	...	...	...	0·50	...	2	2	662	0·47	
40	1,787	22,126	6	0·80	...	...	...	...	...	...	
...	1,339	21,840	6	0·40	...	...	...	...	...	...	
...	...	...	...	...	146	171	(*e*)	...	...	...	
43	11,188·56	227,776	...	...	6,674·56	...	17,760	5,539	4,354,229	...	

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of field operations.		Triangulation. Instrument used.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling operations. Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
Inches to a mile.															
8	3	Katha	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Dharwar town	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forests)	...	6″ & 7″	355	2·1	2·1	138	14	0·50	307	0·40	...	...	...
		Totals	...	...	355	...	...	138	...	...	307	...	...	...	...
6	15	Baluchistan	5	...	...	...	...	...	...	...	...	...	...	...	...
4	14	Central Provinces (Forests).	...	5″ & 6″	2,163	3·7	3·7	137	14	0·45	400	0·54	...	...	...
	17	Bombay (Forests)	...	7″	725	6·5	6·5	102	10	0·20	209	0·30	...	...	...
	18	Himalayas	...	7″	340	1·0	1·0	46	12	0·23	453	0·80	...	...	...
	19	Madras (Forests)	...	6″ & 7″	1,918	2·0	2·0	245	17	0·60	431	1·30	...	...	...
	20	Burma (Forests)	10	5″ & 6″	440	34·0	34·0	9	10	0·30	...	...	...	...	...
	Det.	Chitral	...	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Brch.	Central Provinces (Forests).	...	7″ & 10″	933	...	...	48	...	...	140	...	...	...	...
		Punjab (Forests)	...	7″ & 8″	761	1·5	1·5	51	8	0·49	452	0·65	...	...	...
		North-Western Provinces and Oudh (Forests).	...	7″	247	3·7	4·0	15	7	1·13	51	0·80	...	...	...
		Lower Burma (Forests)	15	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Burma (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	7,527	...	...	653	...	...	2,136	...	...	...	...
2	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	South Maratha Country	...	8″	1,900	2·5	2·1	84	8	0·40	767	3·90	...	...	...
	15	Baluchistan	20	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	Burma (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Orissa	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	1,900	...	...	84	...	...	767	...	...	...	...
1	7	Amherst	25	...	...	...	...	...	...	...	...	...	...	...	...
	11	Upper Burma	...	6″	1,910	4·2	5·1	78	11	0·20	373	0·50	...	...	...
	15	Baluchistan	...	...	...	...	...	...	...	...	...	...	...	...	...
	21	Upper Burma	...	6″	1,700	7·2	9·3	30	9	0·34	181	0·90	...	...	...
	Det.	Indus River	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Chitral	30	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Punjab	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	3,610	...	...	108	...	...	554	...	...	...	...
½	15	Baluchistan	...	6″	4,500	4·1	95·7	15	13	0·70	95	1·0	...	...	...
	Det.	Pamirs	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Waziristan	35	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Chitral	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	4,500	...	...	15	...	...	95	...	...	...	...
¼	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...
	11	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	Baluchistan	40	...	...	...	...	...	...	...	...	...	...	...	...
	21	Upper Burma	...	6″	2,000	17·4	17·2	29	7	0·60	85	1·8	...	...	...
	Det.	Pamirs	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Chitral	...	6″	1,600	...	...	...	...	...	...	...	...	...	...
	Det.	Burma and Siam	...	6″	10,712	130·0	198·0	19	30	1·25	63	2·6	...	...	...
		Totals	45	...	14,312	...	...	48	...	...	148	...	...	...	...
⅛	15	Persia and Arabia	...	...	...	...	...	...	...	...	...	...	...	...	...
	24	Upper Burma	...	12″ micro.	1,350	...	...	...	...	...	...	...	...	...	...
	25	India	...	...	...	...	...	...	...	...	...	...	356·5	37	4
		GRAND TOTALS	49	...	33,554	...	...	1,046	...	...	4,007	...	356·5	37	4

Field Parties during the year 1894-95—(contd.)

	TRAVERSING.				DETAIL SURVEY.						REMARKS.
	Area in square miles.	Stations at which theodolite was set up.	Angular error per station in seconds.	Linear error per *mille*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Fields.	Average size of fields in acres.	
...	...	...	...	...	5	...	...	...	...	...	
...	...	...	...	...	15	...	...	...	...	...	
...	...	1,702	3	0·6	285	179	128	...	...	...	(*f*) Tested *in situ*.
...	...	1,702	...	...	305	...	128	...	...	...	(*g*) Includes 13 square miles of overlap on Madras and excludes 310 square miles of Chilka Lake.
5	...	258	12	20·0	95	...	37	...	...	...	(*h*) Includes 184 square miles of overlap.
...	...	9,297	8	1·3	569	79	275	...	...	...	
...	...	1,060	12	1·1	159	110	26	...	...	...	
...	...	...	...	...	478	46	(*f*)	...	...	...	
...	...	7,721	18	2·2	971	48	(*f*)	...	...	...	
10	...	...	...	...	339	...	(*f*)	...	...	...	
...	...	...	...	...	40	...	...	...	...	...	
...	...	80	...	...	712	160	420	...	...	...	
...	...	...	...	...	14	93	(*f*)	...	...	...	
...	...	2,436	7	3·5	473	174	335	...	...	...	
15	...	...	...	...	76	143	39	...	...	...	
...	...	1,071	4	5·4	195	225	186	...	...	...	
...	...	21,665	...	...	4,026	...	1,281	...	...	...	
...	...	...	...	...	37	...	...	...	...	...	
...	...	...	...	...	2,563	...	400	...	...	...	
20	...	226	20	30·0	80	...	...	...	...	...	
...	...	...	...	...	406	14	(*f*)	...	...	...	
...	...	...	...	...	36	...	(*f*)	...	...	...	
...	959	14,389	...	...	1,026(*g*)	...	...	...	...	...	
...	959	14,615	...	...	4,148	...	400	...	...	...	
25	...	...	...	...	150	...	...	...	...	...	
...	...	...	...	...	1,296(*h*)	5	64	...	...	...	
...	...	...	...	...	420	...	...	...	...	...	
...	...	...	...	...	913	7	73	...	...	...	
...	828	3,630	2	0·7	998	8	67	...	...	...	
30	...	...	...	...	450	...	...	...	...	...	
...	...	...	...	...	282	1·4	(*f*)	...	...	...	
...	828	3,630	...	...	4,509	...	204	...	...	...	
...	...	...	...	...	8,418	...	(*f*)	...	...	...	
...	...	...	...	...	250	...	...	...	...	...	
35	...	...	...	...	3,680	...	...	...	...	...	
...	...	...	...	...	215	...	...	...	...	...	
...	...	...	...	...	12,563	...	...	...	...	...	
...	...	...	...	...	30	...	...	...	...	...	
...	...	...	...	...	2,156	...	...	...	...	...	
40	...	...	...	...	1,570	...	...	...	...	...	
...	...	...	...	...	10,247	...	...	...	...	...	
...	...	...	...	...	4,800	...	...	...	...	...	
...	...	...	...	...	1,900	...	...	...	...	...	
...	...	...	...	...	4,928	...	...	...	...	...	
45	...	...	...	...	25,631	...	...	...	...	...	
...	...	...	...	...	67,000	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	Trigonometrical operations only.
...	...	...	...	...	...	...	...	...	...	...	
49	12,660·27	269,690	...	...	125,383·56	...	19,810	6,205	5,143,271	...	

Statement showing the cost-rates of work executed by the

Number of party.	Nature and *locale* of field operations.	Cost-rate per square mile in rupees.							
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of						
				½″	1″	2″	4″	6″	8″	16″
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹
10	South Maratha Country	9·6	11·6	...	...	14·9	...	...	96·7	...
11	Upper Burma	10·7	...	...	39·0	...	...	...	...	...
15	Baluchistan	2·0	19·9	4·1	20·2	31·2	...	47·4	...	...
18	Himalayas	14·3	...	...	...	36·5	87·7	...	...	...
21	Upper Burma	6·1	...	...	23·2	...	...	...	...	...
Det.	Indus River	...	23·3	...	...	...	...	...	...	...
Det.	Orissa	...	22·6	...	10·5	9·1	...	...	...	...
	Forest Surveys.									
14	Central Provinces	8·9	11·7	...	...	...	67·4	...	...	...
17	Bombay	10·7	11·5	...	...	...	81·0	...	140·3	116·5
19	Madras	10·3		...	...	...	56·2	...	...	...
20	Lower Burma	30·1	94·0	...	...	179·6	153·5	...	...	...
Forest Survey Branch.	Bashahr	...	...	...	27·5	...	...	...	...	...
	Chamba	7·6	...	...	21·1	...	60·0	...	...	...
	Nagpur, Seoni and Chhindwara	9·1	...	...	...	...	51·6	...	...	...
	Narsinghpur and Saugor	9·6	...	...	...	...	54·5	...	...	...
	Raipur	...	15·0	...	...	...	57·8	...	...	...
	Balaghat	...	...	...	...	...	35·8	...	...	...
	Lalitpur	9·4	...	...	...	...	55·3	...	...	...
	Oudh	...	7·3	...	...	...	17·0	...	...	...
	Tenasserim	...	...	...	...	...	89·2	...	...	...
	Pyinmana	...	26·2 (*l*)	...	...	...	88·9	...	...	...
	Cadastral Surveys.									
2 & 8	Darjeeling	...	15·9	...	...	...	...	...	...	150·3
	Singhbhum	...	24·7	...	...	...	...	...	...	...
	Palamau	...	...	...	...	...	...	...	...	80·5
	Gaya	...	52·6	...	...	...	...	...	...	109·2
	Gaya and Patna	...	71·8	...	...	...	...	...	...	...
	24-Parganas	...	...	...	...	...	...	...	...	108·0
	Khulna	...	44·6	...	...	...	...	...	...	107·2
3	Meiktila	...	...	...	...	...	...	...	...	99·4
	Yamethin	...	67·6	...	...	...	...	...	...	93·6
	Yeu and Shwebo	...	61·5	...	...	...	...	...	...	34·3
	Upper Chindwin	...	64·7	...	...	...	...	...	...	106·4
	Katha	...	73·3	...	...	...	...	...	...	76·8
4 & 5	Muzaffarpur	...	...	...	...	...	...	...	...	55·5
	Champaran	...	59·8	...	...	...	...	...	...	65·6
	Saran	...	27·1	...	...	...	...	...	...	...
6	Cachar	...	51·2	...	...	...	...	...	...	53·3
7	Amherst and Thaton	...	56·4	...	...	...	...	...	...	92·1
	Pegu	...	71·1	...	...	...	...	...	...	128·2
12	Magwe	...	69·3	...	...	...	...	...	...	148·6
	Myingyan	...	52·6	...	...	...	...	...	...	130·0
	Traverse Surveys.									
9	Central Provinces	...	36·5	...	...	...	...	...	...	...
Det.	Meerut	...	15·0	...	...	...	...	...	...	...
	Bahraich	...	20·7	...	...	...	...	...	...	...

several Field Parties during the year 1894-95.

	Cost-rate per acre in annas.	Cost-rate per square mile in Rupees.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
	Cadastral survey, including traversing, detail survey and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.		
	Annas.	₹	₹	₹	₹	
.	...	...	...	...	66,142(*a*)	(*a*) Includes ₹7,440 expended on Gujarat General Reports.
.	...	...	...	...	78,967(*b*)	(*b*) Includes ₹7,565 expended on ¼-inch surveys and ₹7,320 on maps of the Mekong Mission surveys.
.	...	...	...	...	74,977(*c*)	(*c*) Includes ₹8,618 expended on ¼-inch and ⅓-inch geographical surveys.
.	...	...	...	...	59,774(*d*)	(*d*) Includes ₹8,074 expended on special forest survey of the Simla Hill States; ₹513 on demarcating the boundaries and revision of the map of the Simla Municipality; ₹820 on instruction of soldier surveyors; ₹933 on survey schools; and ₹9,723 on arrears of mapping.
5	...	...	...	...	77,102(*e*)	(*e*) Includes ₹45,814 expended on ¼-inch geographical surveys.
.	...	...	...	...	30,672(*f*)	(*f*) Includes ₹1,547 expended on special mapping, and ₹214 on copying traverse data.
.	...	...	...	...	56,310(*g*)	(*g*) Includes ₹25,180 expended on arrears of 16-inch cadastral survey.
.	...	...	...	...	85,952(*h*)	(*h*) Includes ₹5,690 expended on classification of forests and soils; ₹4,037 on arrears of mapping and computations; and ₹700 on instruction of soldier-surveyors.
.	...	...	...	...	70,683	(*i*) Includes cost of 4-inch survey of 5 square miles in Bashahr.
10	...	...	...	...	75,803	(*j*) Includes ₹5,217 expended on drawing and publishing maps of Jabalpur and Bhandara divisions.
.	...	...	...	...	1,18,858	(*k*) Includes ₹1,394 expended on publishing maps of Pilibhit and Kheri divisions.
.	...	...	...	...	} 14,997(*i*)	(*l*) Rate calculated per linear mile.
.	...	...	..	...		(*m*) Includes ₹2,264 expended on traversing (principally arrears); ₹75 on traversing of *Jaghirdari* villages; and ₹208 on revision survey.
.	...	...	...	...		(*n*) Includes ₹312 expended on revision survey.
15	...	...	...	..	} 57,393(*j*)	(*o*) Includes ₹805 expended on survey of Tikari Municipality, and ₹509 on *mukarrari* villages.
.	...	...	...	...		(*p*) Includes ₹411 expended on traversing.
.	...	..	...	...		(*q*) Includes ₹3,059 expended on 8-inch survey of gold-fields.
.	...	...	...	...	8,702	(*r*) Includes ₹2,100 expended on Muzaffarpur town survey; ₹390 on Hajipur town survey; ₹45,765 on revision of 410 square miles of 16-inch survey, and ₹580 on revision of 14 square miles of 27-inch survey.
.	...	...	...	...	11,988(*k*)	(*s*) Includes ₹10,287 expended on arrears of work.
20	...	...	...	...	} 26,089	(*t*) Includes ₹4,591 expended on demarcation; ₹1,618 on revision survey; ₹2,337 on training of local men; ₹3,379 on completion of records of Jaintiah *parganas*, and *kanungo* circle maps; and ₹2,810 on 2-inch mapping of Assam Valley.
.	...	...	...	...		(*u*) Includes ₹1,519 expended on demarcation; ₹2,534 on revision survey; ₹3,440 on 2-inch mapping; ₹5,881 on 2-inch, 1-inch and ½-inch topographical surveys; ₹2,600 on completion of Moulmein town maps; ₹520 on completion of Rangoon town maps; ₹1,248 on revision survey of Rangoon town; and ₹624 on verification of Municipal Engineer's survey of Rangoon and Daubon.
.	4·15	...	19·1	20·3	42,314	(*v*) Includes ₹339 book debit charge.
.	...	5·9	...	...	35,954	(*w*) The rate includes cost of traversing of 1893-94.
.	2·55(*w*)	...	27·1	28·9	24,671(*m*)	
25	4·04	4·6	38·2	29·5	21,164(*n*)	
.	...	8·3	...	...	29,566(*o*)	
.	3·71(*w*)	...	65·4	12·7	6,386(*p*)	
.	3·79	20·7	33·7	5·0	4,149	
.	4·11(*w*)	...	...	40·7	13,306	
30	4·03	5·5	9·1	6·7	1 66,517	
.	2·40	5·0	...	6·8	43,536	
.	4·28	5·3	9·1	6·7	30,791	
.	3·75	6·0	9·1	6·7	27,265(*q*)	
.	2·50(*w*)	...	39·1	44·7	1,70,753(*r*)	
35	3·14	5·4	35·9	32·5	1,65,063	
.	...	2·4	...	...	25,525(*s*)	
.	2·61	...	...	28·7	85,174(*t*)	
.	3·71	...	...	...	92,940(*u*)	
.	4·98	...	...	...	1,02,467	
40	5·47	5·0	...	...	1,33,782(*v*)	
.	4·57	4·5	...	...	52,770	
.	...	2·7	...	...	74,049	
.	...	3·9	...	...	33,749	
44	...	4·0	...	...	33,107	

Particulars of Cadastral Surveys completed since 1893-94.

District.	Scale of survey.	Number of villages.	Number of fields.	Area surveyed.	Average size of fields.	Cost, exclusive of demarcation and charge for instruments.	Rate per square mile.			By whom and when surveyed.
							Traverse survey.	Cadastral survey.	Cadastral survey with Record of Rights.	
				Sq. miles.	Acre.	₹	₹ a. p.	₹ a. p.	₹ a. p.	
Cuttack	16″=1 mile	3,001	23,32,669	1,896	0·52	4,02,046	42 0 9	102 4 10	169 2 3	Col. S. H. Cowan, Lieut. R. T. Crichton, Messrs. Patterson and Ewing during 1890-95.
Do. (Revision of survey of 1878-79.)	32″=1 mile	944	8,46,236	364	0·28	40,535	...	39 0 8	111 5 9	Lieut. R. T. Crichton and Mr. R. C. D. Ewing during 1891-95.
Puri	16″=1 mile	1,984	14,78,641	1,029	0·45	2,06,598	51 0 5	107 13 11	134 12 11	Col. S. H. Cowan, Lieut. R. T. Crichton, Messrs. Patterson and Ewing during 1889-95.
Do. (Temple lands) . . .	32″=1 mile	144	98,641	115	0·75	14,537	...	68 11 2	126 6 7	Lieut. R. T. Crichton, and Mr. R. C. D. Ewing during 1892-95.
Balasore	16″=1 mile	3,598	21,51,132	1,729	0·51	2,69,280	37 2 6	76 0 2	120 4 8	Lieut. R. T. Crichton, and Mr. R. C. D. Ewing during 1891-95.
Amherst*	16″=1 mile	805	7,93,723	1,220	0·43	2,28,410	57 7 8	129 11 9	...	Mr. C. Wood during 1890-95.
Magwe	16″=1 mile	2,263	11,95,529	2,922	1·56	5,19,207	53 9 3	124 4 1	...	Messrs. W. H. Patterson, A. E. Spring, H. R. Littlewood and B. G. Gilbert Cooper during 1891-95.

* After the formation of the new district of Thaton.

PART III.

THE OPERATIONS AT THE HEAD-QUARTER'S OFFICES.

604. These offices comprise—

(1) The Head-Quarters Offices at Calcutta.
(2) The Trigonometrical Branch Office at Dehra Dun.
(3) The Drawing Office at Simla.
(4) The Forest Survey Branch Office at Dehra Dun.

A detailed description of the work carried on in each office is given below :—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Colonel Sir H. R. Thuillier, K.C.I.E., R.E., Surveyor-General of India, up to 25th March 1895.
Colonel C. Strahan, R. E., Deputy Surveyor-General in charge Revenue Branch, from 16th October 1894 to 25th March 1895 ; and Surveyor-General of India, from 26th March 1895.
Colonel J. E. Sandeman, S.C., Director of Bengal Survey, from 16th October 1894 to 25th March 1895; and Deputy Surveyor-General in charge Revenue Branch and Director of Bengal Surveys, from 26th March 1895 to 19th April 1895.
Colonel W. H. Wilkins, S.C., Officiating Deputy Surveyor-General in charge Revenue Branch, from 1st to 15th October 1894 and again from 20th April 1895.
Colonel M. W. Rogers, R.E., Assistant Surveyor-General, up to 19th March 1895.
Colonel W. H. Wilkins, S. C., Assistant Surveyor-General, from 16th October 1894 to 19th April 1895.
Mr. T. Archdale Pope, Personal Assistant to the Surveyor-General, from 1st November 1894 to 19th March 1895, and Officiating Assistant Surveyor-General from 20th March 1895.
Mr. C. F. Erskine, Officiating Deputy Superintendent, 2nd grade, on duty from 29th April 1895.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. T. A. Milne, Head Assistant.
Mr. G. C. Walker, Head Clerk.
Babu Kalipodo Banerji, Clerk.
Babu Banimadhab Banerji, „
Babu Chuni Lal Dey, „
Babu Durga Narayan Ghose, „
Babu Ramkristo Chander, „
Mr. H. E. D'Cruz, „
Babu Gopal Chander Dass, „
Babu Kali Kristo Chander, „
and nine others.

Accounts.

Mr. C. O. Gray, Head Clerk.
„ J. A. Vallis, Clerk.
Babu Rajkrishna Mukerji, „
Mr. E. A. Bonnaud, „
Babu Hem Nath Dutt, „
and 7 others.

605. The general direction of these offices remained in the hands of Colonel Sir H. R. Thuillier, K.C.I.E., R.E., up to the 25th March 1895, and thereafter in those of Colonel C. Strahan, R.E. The Revenue Branch section was under the superintendence of Colonel Strahan, R.E., up to the 25th March 1895, of Colonel J. E. Sandeman, I.S.C., from 26th March to 19th April, and under Colonel W. H. Wilkins, I.S.C., from 20th April 1895 to the close of the year. The General and Topographical Branch sections were under Colonel M. W. Rogers, R.E., up to the 19th March 1895, and thereafter under Mr. T. A. Pope. The office of the Personal Assistant was held by Mr. Pope up to the 19th March 1895.

The Bengal Surveys were under the direction of Colonel J. E. Sandeman, I.S.C., up to the 25th March 1895. On his appointment as Deputy Surveyor-General in charge Revenue Branch, he carried on the duties of the Director of Bengal Surveys in addition, and this arrangement continued during his leave when Colonel Wilkins conducted the duties of both offices.*

*The Assistant Surveyor-General reports as follows :—

Mr. T. W. Babonau, Registrar, has carried on the general superintendence of the office in a very satisfactory manner.

Messrs. Milne and Gray have continued to give satisfaction in the management of their respective sections. Mr. J. A. Vallis too has carried on satisfactorily the duties connected with the transhipment of the Survey *khalasis* to Burma.

The clerks have continued to work well, of whom the following again deserve to be specially mentioned :—Babus Bani Madhub Banerji, Chuni Lal Dey, Rajkrishna Mukerji, Mr. E. A. Bonnaud, and Babus Gopal Chander Das, Kanti Chander Sen and Mohendro Chander Aich.

The Deputy Surveyor-General reports that in the Revenue Branch Office, Babus Kalipodo Banerji, Ramkristo Chander and Norendro Nath have continued to discharge their duties satisfactorily. Mr. H. E. D'Cruz has also worked well.

DRAWING OFFICE.

606. The Drawing Office was under the superintendence of Mr. B. G. Gilbert-Cooper, up to the 28th November 1894, and then under Mr. T. A. Pope until the return of Colonel W. H. Wilkins on the 28th December 1894. Mr. C. F. Erskine assumed charge of this office from the 29th April 1895.

607. Mr. L. J. Pocock held the post of Chief Draftsman throughout the year.

608. There has been no change in the organisation of this office during the year. The three sections into which it is divided are reported on separately, and a detailed statement of work done by each section is given in the appendix.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge from 28th December 1894, up to 28th April 1895,
Mr. T. A. Pope, Deputy Superintendent, 2nd grade, in charge from 29th November up to 27th December 1894,
„ B. G. Gilbert-Cooper, Assistant Superintendent, 1st grade, in charge from 1st October up to 28th November 1894.
„ C. F. Erskine, Assistant Superintendent, 1st grade, in charge from 29th April 1895.
„ L. J. Pocock, Chief Draftsman,
„ W. Stotesbury, Head Draftsman. up to 25th May 1895.
„ G. D. Cusson, Officiating Head Draftsman, from 26th May 1895.
„ J. A. Higgs, Draftsman, up to 25th May 1895.
„ W. Green, Draftsman,
„ A. J. Musgrove „
„ J. R. Adels „
„ R. C. Sinclair „
„ A. S. Bateman „
„ N. G. Watson „ up to 20th April 1895,
„ A. J. Rodrigues, Draftsman,
„ A. J. Wilson Jr. „

Native Draftsmen,

Babu Mohesh Chandra Shaw, up to 5th April 1895.
„ Purna Chandra Sen.
Munshi Muttiullah.
Babu Gopal Chandra Roy.
Munshi Abdul Aziz.
„ Rahim Bakhsh.
Babu Tincory Sen.
Munshi Abdul Razak.
Babu Bacharam Banerjee.
„ Ram Chandra Sen.
„ Sarat Chandra Chatterjee.
Munshi Nur Bakhsh.
Babu N. N. Mukherjee.
„ S. C. Sarkar,
and 46 others.

Additional Establishment.

Mr. G. D. Cusson, Draftsman, up to 25th May 1895.
„ J. A. Higgs, Draftsman, from 26th May 1895.
7 Native Draftsmen.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. A. J. Wilson, Sr., Extra Assistant Superintendent, 1st grade, up to 1st November 1895.
„ A. G. Wyatt, Extra Assistant Superintendent, 2nd grade, up to 25th October 1894.
„ J. A. Barker, Extra Assistant Superintendent, 5th grade.
„ G. C. Swiney, Extra Assistant Superintendent, 5th grade, up to 27th October 1894.
„ G. E. Parker, Extra Assistant Superintendent, 5th grade, from 12th to 30th November 1894.
„ G. Campbell, Extra Assistant Superintendent, 6th grade, from 1st November 1894.
„ W. C. G. Barckley, Extra Assistant Superintendent, 6th grade.
„ S. O. Madras, Sub-Assistant Superintendent, 1st grade.
„ W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade.
„ T. J. J. Mills, Sub-Assistant Superintendent, 1st grade, up to 2nd May 1895.
„ J. Smith, Sub-Assistant Superintendent, 1st grade.
„ T. W. Babonau, Jr., Sub-Assistant Superintendent, 2nd grade, up to 29th May 1895.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

609. The preparation of maps of Burma on various scales has been the principal work of this section. On the quarter-inch scale, sheets Nos. 15 N.W., and 15 S. W., of the North-East Frontier series, and sheets Nos. 2 N. W., and 2 S.W., of the South-East Frontier series, mentioned in the last Annual Report as well advanced, have been completed. Sheets Nos. 15 S.W. and 2 S.W. only have been published, whilst the other two sheets are awaiting return of proofs from local authorities. Two new maps, sheets Nos. 3 S.E., 3 A. N. E., of the South-East Frontier series, were started during the year and are well advanced.

610. Of the maps on the 8-mile scale, referred to in last Annual Report, the compilation of the second edition of sheet No. 23 of the North-East Frontier series has been held in abeyance, as it appeared desirable that the new geographical details to be obtained from the survey of No. 21 Party, during season 1894-95, should be incorporated before this map is again published. For a similar reason sheets Nos. 4, 5, 6, 10, and 13, of the South-East Frontier series are still in progress as useful geographical data are forthcoming from the late survey of the Mergui Detachment and No. 11 Party. A fresh edition of sheet No. 1 is also in hand as the topography was found not to be in accordance with the latest $\frac{1}{4}$ inch sheets received from the field party, since the publication of the previous edition. Sheet No. 9 of this series has been printed and final press order is held over pending receipt back of certain proofs, and will probably be published before this report is printed.

611. Of the provincial maps on the scale of 1 inch =16 miles, a new map of Bengal in outline has been published during the year; a second edition of the map of Upper Burma, mentioned in paragraph 653 of last Annual Report, was completed and published during the year; the outline map of the Punjab has had the hill shading completed for printing in two colours; and the other provinces belonging to this series have been brought up to date with additions and corrections to either railways or boundaries.

612. The 32-mile map of India, third edition, completed last year, still awaits the orders of the Government of India regarding frontier boundaries, that are to be inserted before it can be published. The 256-mile map of India, has been revised and the hill shading completed for engraving.

613. The sheets of the Atlas of India have been kept up to date as far as possible. Ten sheets of this series received additions to hill drawing, and twenty-four sheets additions and corrections to outline and names, whilst thirty-two sheets were brought up to date, with additions to railways, roads, canals, and changes to boundaries for engraving.

614. The completion to margin of the various maps of the Central India Agency, of the Central Provinces, and of Rajputana, scale 1 inch=1 mile was continued during the year. Eight of these sheets have been published, and twenty-six are in various stages of progress.

615. Some of the maps for the second edition of the Statistical Atlas of India for the Revenue and Agricultural Department have been completed and published. Other Statistical maps of India showing canals, railways, etc., have also been revised and will probably be ready for publication by the time this report is issued.

616. The office copies of all maps have been kept up to date with information supplied by the Public Works Department and the Quarter Master General's Department. A large amount of miscellaneous work has also been done, including administration report maps, district maps, index maps, the reduction of record plans, and the incorporation of data supplied by other Departments.

SECTION II.—REVENUE.

617. The work of this section consists in examining, and preparing for photo-zincography, the fair maps received from the field parties of the Revenue Branch; in bringing up to date and republishing the old maps; in the preparation of index maps for field parties, and for the General Report; in colouring maps on various scales, for the guidance of colourists in M. R. I. O., and for office copies; and also in tracing maps and plans for, and supplying data to, Government officials and others.

618. Two standard sheets of the Southern Maratha Country on the 2-inch scale have been filled up to margin from the latest survey materials of the Bombay Forest Survey of the North Kanara district; and three sheets of Lower Burma on the same scale have been partially completed for a second edition from the 2-inch scale maps of the local surveys.

619. A map of the Calcutta suburbs on the 3-inch scale has been compiled in four sections from the 6-inch map of Calcutta, and the original 4-inch maps, surveyed in 1892-94.

620. Two maps showing the river Hooghly and the country adjacent to the river banks, have been compiled from the 6-inch maps of the Hooghly river survey, for reduction to 2 inches to a mile. Of these, sheet No. 2 is under publication, and the drawing of sheet No. 1 is well advanced.

621. In addition to the regular work of the section, a considerable amount of mapping, has, as usual, been done for other departments. A map of Lucknow and environs, as existing before the Indian mutiny, showing the British position, and military operations during the siege of 1857-58, has been prepared for the Military Department of the Government of India. A similar map of Cawnpore is also being prepared for photo-zincography.

622. Of the ½-inch district maps of the North-Western Provinces being prepared for the Local Government, that of Almora has been published; those of Mirzapur and Naini Tal are under publication, while that of district Garhwal has been held in abeyance pending receipt of further instructions from the district officials.

623. The traverse computations of the field parties working in the district of Bankura in Bengal, Prome in Lower Burma and Killa Kanika in the Orissa division of Bengal, have been examined. A large amount of work in calculating areas and furnishing data, has been done for field parties, and districts officers, etc. The areas of 16 sheets were calculated from the maps themselves, and the areas from 479 field sections of the Calcutta town survey, on the scale of 50 feet=1 inch, also the areas of Buxa forest in district Jalpaiguri, and of Government lands in Kujang forests. The areas of districts of Dehra Ghazi Khan in the Punjab and Darjeeling in Bengal were revised in accordance with the latest details received.

624. The amount of correspondence dealt with has increased, 1,556 letters having passed through this section, as against 1,300 last year.

SECTION III.—CADASTRAL.

625. This section is employed in preparing the original maps of all cadastral surveys (except in Bengal) for zincography and photo-zincography. The procedure adopted is to examine the numbering of the fields, and to note that all holdings and divisions of land are correctly tabulated in the area statements, before sending the maps to press.

626. The returns for the previous year showed that in the North-Western Provinces, five sheets remained to be published; these have been published during the year under report, and in addition 71 sheets of Jhansi district were reprinted at the request of the Forest authorities. The maps of Garhwal district have not yet been dealt with, as orders sanctioning their publication have only just been received.

627. In Burma the publication of the maps of the following districts has been proceeded with:—*viz.*, Amherst, Mergui, Tavoy, Lower Burma, and Meiktila and Sagaing in Upper Burma. Of the Lower Burma sheets 2,115 have been published, and of Upper Burma 1,183 sheets; in addition to these 20 sheets of the survey of the town of Rangoon, with index, on scale 16 inches=1 mile have been published, and 1,606 sheets of Upper Burma have also been prepared for publication.

628. In Assam the publication of maps of the Darrang district has been completed, and 14 sheets which have been in hand since 1888, have been published at the request of the Director of Land Records of Sylhet (Jaintia); 643 sheets have also been published, thus completing the district. The districts remaining incomplete are Kamrup 3 sheets, Sibsagar 8 sheets, Sylhet 45 sheets; these sheets consist mostly of blocks of waste land, and are not to be published.

629. During the year 99 volumes of original maps have been arranged and bound for record in this office. The total number of maps passed for publication during the year was 4,115; of these 3,981 were actually printed, 3,052 having been photo-zincographed, and 929 zincographed at the close of the year. There remain to be published 2,004 sheets, against 2,598 at the close of the last year, showing a decrease of 594 sheets.*

BENGAL PROVINCIAL DRAWING OFFICE.

630. This office remained under the superintendence of Captain J. M. Fleming, S.C., from the beginning of the year under report until the 25th June 1895, when he was relieved by Captain G. B. Hodgson, S.C., and proceeded on privilege leave.

Personnel.

Captain J. M. Fleming, S. C., Deputy Superintendent, 2nd grade, in charge up to 25th June 1895.
Captain G. B. Hodgson, S.C., Deputy Superintendent, 1st grade, in charge from 25th June 1895.
Mr. T. Shaw, Extra Assistant Superintendent, 6th grade.
„ P. A. Peters. Extra A sistant Superintendent, 6th grade, up to 20th March 1895.
„ P. C. H. Smart, Sub-Assistant Superintendent, 1st grade, from 6th February up to 2nd September 1895.
Babu S. C. Sen, Sub-Assistant Superintendent, 2nd grade,
„ Nilmony Chatterjee, ditto ditto, from 24th September 1895.
Ten native draftsmen.

631. The maps which have been dealt with during the year are those of the Western Duars, Orissa

* Mr. Pocock and Mr, Stotesbury in their posts as Chief and Head Draftsmen, respectively, supervised their establishments most efficiently. Mr. Cusson has also done good work since taking up the post of Officiating Head Draftsman. Messrs. Barker and Higgs have also done very well as heads of the Examining and Cadastral Sections. Mr. Barckley has also done good work. The European Draftsmen have been well reported on ,especially Mr Sinclair, and of the native establishment Babu Sarat Chandra Chatterjee and Narandra Nath Mookerje, amongst others, have rendered good service.

and Bihar; and the procedure consisted as before in the compilation of standard quarter sheets on the 2-inch scale for reduction by photography to the 1-inch scale.

632. At the close of last survey year only a small amount of topographical detail, together with the final examination and the extraction and entry of *pargana* areas, remained to be done on the sheets of the Western Duars. The sheets were not completed until March, the delay being chiefly due to the extraction of these areas. The gaps remaining amid the tea grant area which had not recently been surveyed professionally, and of which tea grant maps were not available, have been filled in from data available from topographical maps. The Bengal Duars Railway has also been professionally surveyed and entered on the sheets.

As ordered by the Board of Revenue, proof copies of the sheets have been forwarded to the district authorities for the insertion of *thana* and *tahsil* boundaries, also of additional names of *hâts*, etc., which were not ascertained at time of survey, and these have been received back, and the additional information obtained has been entered on the sheets, which are now practically ready for publication. There are nine 1-inch sheets.

633. A considerable amount of progress has been made with the sheets of Orissa on which the greater part of the Drawing Office establishment has been employed. The necessity for correcting and revising a considerable number of the sheets drawn in Orissa has, however, much delayed the work. The plotting was found to have been carelessly done. The co-ordinates are now being revised and the plotting corrected when necessary. A large number of the village names typed on the finished sheets have also now to be corrected, as they were found to differ from the corrected names on the 16-inch sheets.

But the chief reason for not obtaining a larger outturn has been the difficulty in procuring a regular supply of sheets from the field party, or rather in retaining the sheets when received long enough to make use of them, as they were required again in the office of the party. All through the year consignments of sheets were received from the party, but had hardly been entered in the office books when urgents demands were made for the return of some or all of the sheets for revisions, etc., in the field. With work thus scattered, it is almost impossible for the supervising officers to check the draftsmen's progress.

During the year 9,224 16-inch sheets were received from Orissa, and 3,213 reductions have been made and transferred to the fair sheets. A large number of the remaining villages had been previously reduced by pentagraph directly on to the 2-inch sheets.

Besides the 16-inch sheets, 43 2-inch sheets have been received, and the topography thus available is being inserted in the portions of the sheets unsurveyed on the 16-inch scale, and consequently hitherto blank on the fair maps. Not much progress, however, has been made with these, for, as usual, the Orissa detachment requested the return of most of the field sheets. When these sheets have been received back, and the contained topography transferred to the fair sheets, which should not take long, several complete 1-inch sheets can be forwarded for publication, and two or three months should see the Orissa mapping completed.

634. The Bihar mapping has been carried on throughout the year as material was available, but the supply has been most uncertain and latterly failed altogether, as the officer in charge was unable to supply any field sheets. As in Orissa, field sheets or traverse volumes were usually only received to be asked for again at once. Though latterly the mapping has not been added to, draftsmen have been employed on the sheets preparing margins, etc. The mapping done has been almost entirely in the Muzaffarpur district, though latterly a commencement has been made with the maps of Saran, of which district a considerable number of field sheets have just been received.

The values of the corners of 2-inch sheets for the three districts—Muzaffarpur, Saran, and Champaran—have been worked out, and a considerable number of sheets plotted and prepared for mapping.

During the year 2,897 16-inch sheets have been received in the office, and of these 1,294 have been reduced, and for the most part transferred to the fair maps. The sheets not taken in hand are chiefly those of Saran district, which have only recently come to hand.

635. The following statement shows the progress of 2-inch mapping during the year :—

Province.	Total number of sheets.	Graticules projected.	Stations plotted.	Details reduced by pentagraph from 16-inch to 2-inch scale.	Names of villages, streams etc., typed.	Outlining completed.	Foot notes, margins, etc., completed.	Examined.	Finally examined.	Remarks.
Orissa { Previously reported	...	56	56	46	38	38	15	9	...	(a) Number of sheets increased since last year owing to inclusion of 2" surveys, 1894-95. Of these 94 sections, 18 contain no topographical details.
Orissa { Completed during year	...	11	...	14	8	10	21	20	...	
Totals	94(a)	67	56	60	46	48	36	29	...	
Bihar { Previously reported	...	14	11	4	2	2	...	...	...	
Bihar { Completed during year	...	11	11	9	10	10	...	...	...	
Totals	...	25	22	13	12	12	...	...	...	

636. The native establishment, which at the commencement of the work was for the most part very inferior, has much improved, and some of the hands promise to turn out very fair draftsmen. The office was inspected by the Director of Bengal Surveys on several occasions during the year, and he was satisfied with the progress made.

ENGRAVING OFFICE.

637. The superintendence of this office during the year under report has been held by the several officers shown in the *personnel*.

Personnel.

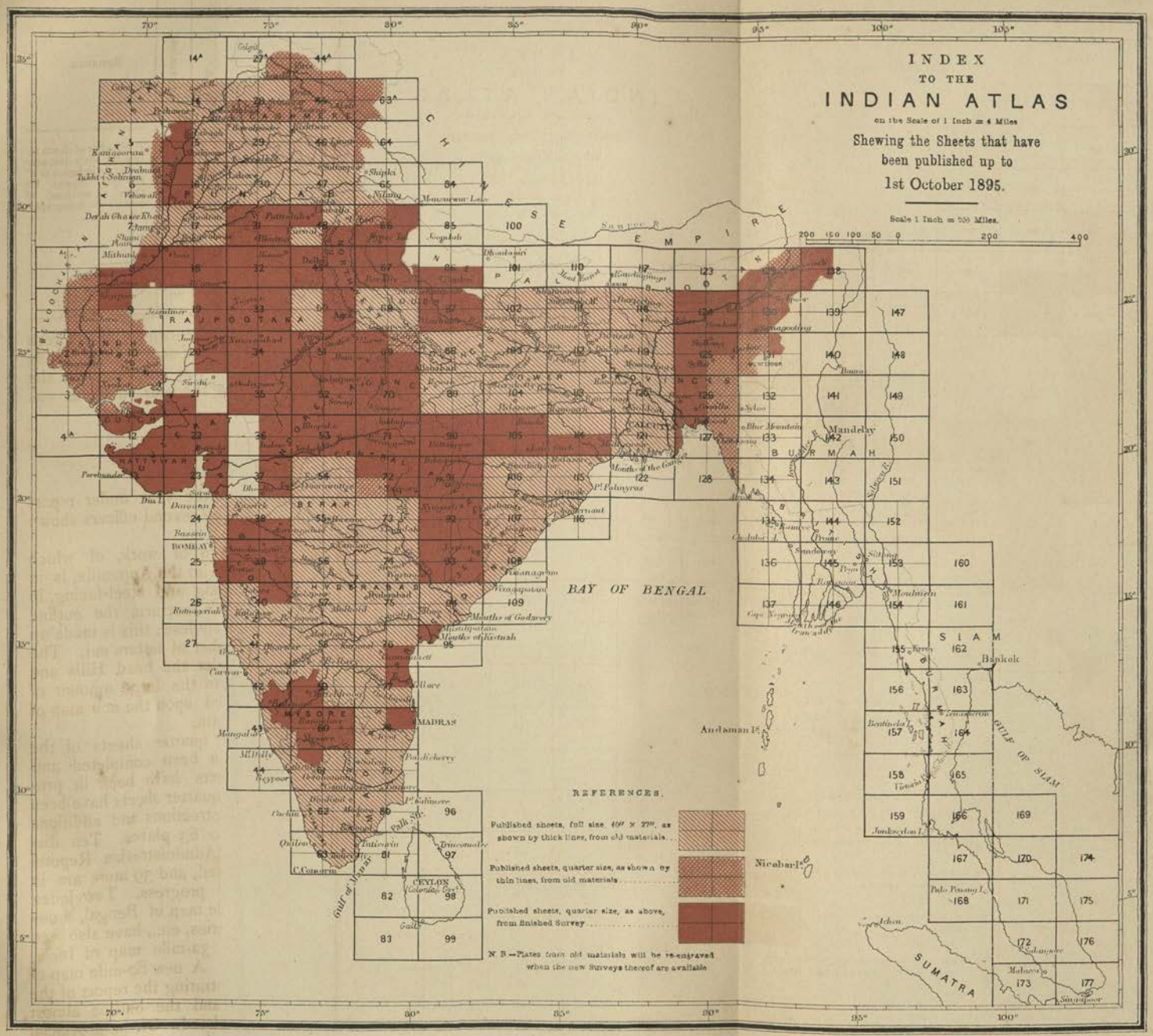
Colonel W. H. Wilkins, S.C., Assistant Surveyor General, in charge from 28th December 1894 up to 19th April 1895.
Mr. T. A. Pope, Deputy Superintendent, 2nd grade, in charge from 28th November up to 27th December 1894.
Mr, G. B. Gilbert-Cooper, Assistant Superintendent, 1st grade, in charge up to 27th November 1894.
Mr. C. F. Erskine, Officiating Deputy Superintendent, 2nd grade, in charge from 29th April 1895.
Mr. J. Fulford, Head Engraver.
„ W. Donaldson, Engraver.
„ S. M. Coard, „
„ T. B. Rodger, „
„ A. W. N. James, „
„ A. R. Coard, „
„ E. C. V. Ollenbach, „
„ E. Earle, „
„ L. H. Musgrove, „
„ F. R. C. Scallan, „
„ A. T. Vieux, „
„ A. E. Cann, „
22 Native Engravers.
2 Apprentices.

Copper-Plate Printing Section.

Mr. W. T. Collins, Copper-Plate Printer.
„ A. E. Pilley, Assistant Copper-Plate Printer and Store-keeper.

638. The outturn of work, of which a summary is given in the Appendix, is in writing, hills, printing and steel-facing, in excess of last year's outturn, the outline alone being slightly less; this is made up by the larger number of letters cut. The great increase under the head Hills and ornament is due to the large amount of ornament engraved upon the new map of the town of Calcutta.

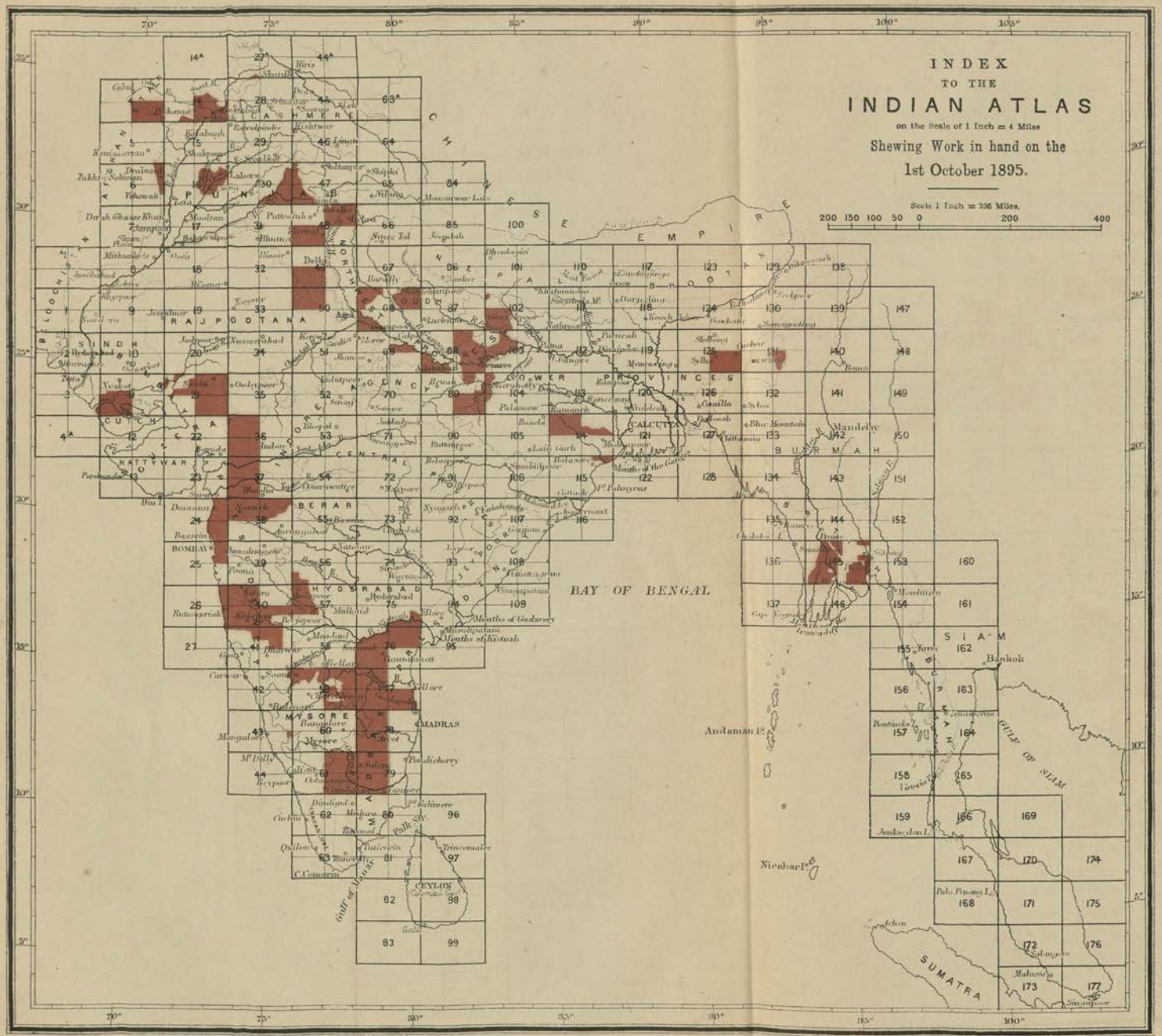
639. Seventeen quarter sheets of the Indian Atlas have been completed and published, 31 others have been in progress, nine new quarter sheets have been projected, while corrections and additions have been made to 63 plates. Ten district maps for Administration Reports have been completed, and 39 more are in various stages of progress. Two index maps and a 64-mile map of Bengal, showing district boundaries, etc., have also been completed. The 32-mile map of India, without hills, has been completed as far as possible. A new 80-mile map of India, showing railroads, which will be used for illustrating the report of the Director General of Railways, has been projected, and the outline almost completed. The 128-mile map of India is almost completed. Of the provincial maps, the 16-mile map of the Bombay Presidency is in progress. The 16-mile map of Gujarat is almost completed in outline and writing. Three out of the six plates, of the Madras Presidency, on the same scale, have been completed in writing, and the writing is well advanced; the corrections to the 16-mile map of Punjab and Kashmir have been put in hand, and the hills have also been commenced in the map of Mysore and Coorg.



Sess. No. 664 S. I. D.—Nov. 95.—350.

Litho., S. I. O., Calcutta.

No. 526-S. 95.



Reg. No. 554. S. I. D.—Nov. 95.—550.

Litho., S. I. O., Calcutta.

No. 525-S. 95.

640. The outline and writing on the 16 inches = 1 mile map of the town of Calcutta has been completed; the shading and ornament is well advanced, the plates being almost ready for publication. Three plates for the professional volume, containing scale and miscellaneous plates, have been completed.

641. The Copper Plate Printing Section pulled 25,504 impressions. The Steel-facing Section dealt with 237 plates.*

THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

642. Mr. T. A. Pope was in charge of the office from the 1st October till the 30th November when Colonel J. Waterhouse returned from special leave and resumed the charge, which he held till the end of the year.

Personnel.

Colonel J. Waterhouse, Assistant Surveyor-General in charge from 30th November 1894.
Mr. T. A. Pope, Officiating Assistant Surveyor-General up to 29th November 1894.

NORMAL ESTABLISHMENT.

Lithographic and Printing Division.

Mr. H. L. Lepage, Head Assistant.
„ E. Dowling, Head Draftsman.
Babu Ambica Charn Mukharji, Draftsman.
Munshi Sobhan Bakhsh, Examiner, up to 15th July 1895.
One apprentice, 28 draftsmen, and 6 colourists.

Lithographic and Zinc Printing Section.

Mr. B. Mackenzie, Head Printer.
„ D. Deas, Chromo-litho-printer, from 10th April 1895.
„ F. R. Vandyke, officiating up to 9th April 1895.
„ S. U. Ravenscroft, Assistant Chromo-litho. Printer.
„ J. B. Mackenzie, Assistant Zincographer.
„ P. Michael, Machine Printer, up to 4th May 1895.
„ C. Andrews, Machine Printer, from 1st July 1895.
2 machine printers, 1 apprentice, 15 litho. and zinc printers, 9 machine men, 17 spongemen, 40 pressmen, 1 paper wetter, 2 stone grainers, 2 stone polishers, 4 zinc grainers, 1 ink grinder, 1 engine driver and 1 fireman.

Type Section.

Mr. E. De Pyvah, Head printer.
12 compositors, 3 type printers, 3 inkmen, 3 mates, 2 machine type printers, 2 machine inkmen, 1 impositor, 1 roller moulder, and 1 boy.

Photographic and General Division.

Mr. J. Harrold, Photographer, from 9th January 1895.
„ C. J. Meade, Assistant Photographer.
„ C. Andrews Do., up to 30th June 1895.
„ F. U. Murphy, Do.
Munshi Ismail Khan, Do.
„ Habibul Hassain, Do.
5 Assistant photographers and 8 labourers.

Heliogravure Section.

Mr. A. W. Turner, Photo-engraver.
„ J. T. Meade, Assistant Do.
1 Apprentice, 1 Assistant Photo-engraver, 1 engraver, 1 Assistant engraver, 4 copper-plate printers, 6 pressmen and 11 plate polishers.

Correspondence, Stores and Account Section.

Mr. W. Moore, Store-keeper, up to 31st March 1895.
„ R. George, officiating from 1st April 1895.
Babu Kanny Lall Sen, Head Clerk and Accountant.
„ Kedar Nath Ghose, Clerk.
„ Gopal Chandra Mukharji do.
„ Surja Kumar Banarji do.
„ Rajani Kantha Chattarji do.
4 clerks and one paper-keeper.

CADASTRAL ESTABLISHMENT.

Photographic Section.

Mr. H. Haward, Head Assistant, from 9th January 1895.
„ J. Harrold, officiating up to 8th January 1895.
„ R. George, Photographer up to 31st March 1895.
„ L. Lagnier, Photographer.
„ T Lloyd, do.
8 Assistant photographers.
10 labourers.

Zinc Printing Section.

Mr. E. A. LeFranc, Zincographer.
„ F. R. Vandyke, do.
„ G. A. LeFranc, do. up to 4th May 1895.
„ P. Michael, from 5th May 1895.
Babu Khetter Mohan Das, Clerk.
9 zinc correctors, 9 zinc-printers, 10 spongemen, 17 pressmen, 11 zinc-correctors and one clerk.

643. There have been few changes in the *personnel* of the office during the year. Mr. Haward, the Photographic Head Assistant, returned from furlough on the 9th January and Mr. D. Deas on the 10th April 1895. Mr. G. A. LeFranc, Zincographer, was transferred to the Dehra Dun Office on the 4th May. Munshi Sobhan Baksh, Examiner in the Lithographic Drawing section, retired on the 15th July. Mr. J. De Silva was appointed as apprentice on the 1st May.

644. The machinery has not worked quite so steadily as in former years, partly owing to the want of sufficient work to keep the three Lithographic machines constantly employed. In February one of the pistons of the engine gave way and was repaired by Messrs. Burn & Co. in about a fortnight. Some trouble was also found in working the Worthington feed-pump attached to the boiler and it had to be put in order by Messrs. Marshall & Co. The machinery has now been running

* The Head Engraver, Mr. Fulford, has given great satisfaction, in the discharge of his duties, and he reports well of all his establishment.

regularly for about 4½ years and signs of wear must be expected. The number of impressions from the three machines was 671,216 and the greater part of the work is now printed off in this way.

645. The general abstract of work turned out is given in the tabular statement below. Owing to a further diminution in the number of subjects sent in for reproduction, especially in cadastral survey sheets, the work generally shows a decrease, but in other respects the outturn is well up to the average.

General Abstract of Work done during the year 1894-95.

Classification.	Photo-zincographic and Lithographic Printing.										Type Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.
	Sheets or Subjects.	Negatives and transparencies.	Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates Printed.	Stones.	Pulls.	Number of Copies.			Pages or Items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Heliogravure Prints.	Heliogravure Plates.	Photo-Blocks.	Electroty pes.	
								Colored.	Uncolored.	Total.										R a. p.
Departmental maps, etc.	793	1,022	981	409	598	72	190,465	39,632	172,167	211,799	11,679	1,291,041	652,175	76	2,518	10	1,441	...	7	71,857 12 0
Cadastral maps	3,859	2,873	2,955	4,002	4,002	...	146,620	...	138,800	138,800	...	...	...	...	...	...	...	...	...	58,534 4 0
Extra-Departmental Maps and Plans	1,256	884	688	348	644	361	557,201	104,888	466,355	571,243	...	...	...	576	650	75	48,234	6	...	76,534 11 0
Totals	5,908	4,779	4,624	4,759	5,244	433	894,286	144,520	777,322	921,842	11,679	1,291,041	652,175	652	3,168	85	49,675	6	7	206,926 11 0
Totals of 1893-1894	6,862	5,553	5,835	5,575	5,981	486	1,039,071	167,997	907,908	1,075,905	10,785	1,564,453	820,605	1,335	2,648	86	50,678	4	18	237,673 4 0
Differences	− 954	− 774	− 1,211	− 816	− 737	− 53	− 144,785	− 23,477	− 130,586	− 154,063	+ 894	− 273,412	− 168,430	− 703	+ 520	− 1	− 1,003	+ 2	− 11	− 30,746 9 0

The printed outturn of the lithographic and zincographic presses and machines was 894,286, or 144,785 less than last year. The number of departmental maps reproduced, both Normal and Cadastral, was very much less than last year, but there was a great increase in the number of extra-departmental subjects reproduced, as well as in the number of copies printed from them. In the Type-Printing section the number of items set up shows a fair increase, but the number of pulls and copies is very much less. Part of this decrease and also of that in the outturn of the lithographic and zincographic work may be attributable to the stoppage of the engine.

In the Silver-Printing section there has been an increase in the number of blue prints with a decrease of silver prints, which are always fluctuating. The work in the Heliogravure section is about the same as last year, but shows a slight decrease in plates and prints.

646. The publication of the third edition of the 32-mile map of India, so long delayed, has again been postponed pending the final settlement of the boundaries on the North-East and North-West frontiers. Some further corrections were made on sheets 1 and 4 during the year, and more have yet to be made.

647. Among the General and Provincial maps published during the year may be noted a revised skeleton map of India showing Provincial and District boundaries on the scale of 1 inch=64 miles, a very useful map for the compilation of statistical maps. The 24-mile chromo-lithographed map of Afghanistan, mentioned in last year's report as commenced, made good progress, but is now awaiting further new material and revised boundaries. One sheet is finished and the outline and names and a portion of the hills of the other one. The skeleton map of the Punjab and Kashmir on the scale of 1 inch=16 miles was reprinted with corrections and additions, also a second edition of the map of Upper Burma (with hills) on the same scale.

648. The list of District maps published during the year includes Districts Gorakhpur and Almora, on the scale of 1 inch=2 miles, specially prepared for the North-Western Provinces Government, and Districts Kamrup, Mymensingh, Sonthal Parganas, Lohardaga, Burdwan, Malda, Darbhanga, Cachar, and Sylhet on the 4-mile scale taken from the engraved atlas sheets. Similar maps of Districts Noakhali, Manbhum, Rungpur, Jessore, Muzaffarpur, Khulna, 24-Parganas, Hissar, Nowgong, Bankura, and Hazaribagh, were transferred to stone.

649. The number of sheets of standard maps on the 4-inch, 2-inch, 1-inch, ½-inch, and ¼-inch scales which have been in hand, either for reprinting or publication was 319; 70 sheets were published on the 1-inch scale during the

Hills put in by Heliogravure

Published under the direction of Colonel C. Strahan, R.E. Surveyor General of India.

December, 1895.

Engraved at the Survey of India Office, Calcutta.

No 663-S. 95

year, including 10 of Bengal; 12 of Bombay, besides 2 on the 2-inch scale; 8 of Lower Burma, besides 30 on the 4-inch scale; 2 of Upper Burma; 6 of Central India and Rajputana; 4 of Hyderabad, Deccan, besides 1 sheet on the scale of 1 inch=2 miles; 15 sheets of the Indus Riverain Survey (7 sheets 2nd edition); 9 of the North-Western Provinces and Oudh; 1 of Madras; 3 of the Punjab. Of the North-Eastern Frontier on the scale of 1 inch=4 miles, 4 sheets were published and one sheet on the scale of 1 inch=8 miles. Of the South-Eastern Frontier 6 sheets were published on the 4-mile scale and one on the 8-mile scale.

650. The printing off of the sheets of the new survey of the City of Calcutta on the scale of 1 inch=50 feet was completed, and several sheets have been reprinted. A new map of Calcutta and suburbs on the scale of 3 inches =1 mile, in 4 sheets, was reproduced, but had not been published at the close of the year. Other city and cantonment plans published during the year were:—Belgaum in 2 sheets, on the scale of 8 inches=1 mile; Rawalpindi and Environs in 2 sheets, on the scale of 2 inches=1 mile and a re-issue of Mysore City in 6 sheets on the scale of 12 inches=1 mile, with additions to 1894.

651. The miscellaneous maps include 38 sheets of the Madras Forest Surveys on the scale of 4 inches=1 mile and a map of the scene of operations of the Chitral Relief Force, taken from the 24-mile map of Afghanistan.

652. The extra-departmental work shows a very considerable increase in nearly all sections over last year, the number of subjects sent in for reproduction being 1,256, against 1,162 of 1893-94, while the number of pulls from stone or zinc was 557,201, against 508,565, and the total value of the work done ₹76,534, against ₹71,141. In the Heliogravure section the extra-departmental work has been somewhat less than last year.

A number of extra-departmental maps, etc., which were commenced last year were printed off and completed during the year, among them the remaining plates of the new Statistical Atlas of India, the Geological Map of Hazara, the plan of the City of Amritsar, in 8 sheets on the scale of 1 inch=88 feet, and the remaining plates of the Bower manuscript. One hundred and two plates illustrating Volume II of Mr. Smith's Report on the Mogul architecture of Fatehpur-Sikri, were reproduced, but had not been printed off at the close of the year. One hundred and three plates to illustrate Dr. Führer's Report on the Great Jaina Establishment at Mathura were also reproduced, but not printed off. A large number of weather-charts and meteorological diagrams have been supplied to the Meteorological Office, as well as 11 of the series of manœuvre maps, 10 miles round cantonments, and others for the Military authorities.

653. Under the arrangement that the maps and plans of the Penang Survey executed under the Government of the Straits Settlements should be reproduced in this Office, nine sheets (including the title sheet) of the plan of George Town on the scale of 1 inch=60 feet were printed off, and 32 sheets (including title sheet) of the Penang Survey on the scale of 5 inch=1 mile were received and reproduced, but had not been printed off at the close of the year.

654. Several sheets of the outline map of Siam on the scale of 1 inch=12 miles have been reproduced for the Siamese Government, including 2 sheets in English, 10 sheets in Siamese, and 1 triangulation sheet; Mr. H. V. L. Nicolay, an employé in the Royal Survey Office at Bangkok, went through a practical course of photo-zincography and heliogravure. At the request of Col. Wace, R.A., Inspector General of Ordnance, Sub-Conductor Maher, attached to the Gun Carriage Agency in Fatehghar, received a course of instruction in photography and photo-zincography, in order to qualify him for reproducing drawings, etc., for the Agency.

655. In the Heliogravure section the principal work has, as usual, been extra-departmental and includes 11 plates of the Technical Art series, 12 plates of fishes and crustacea, illustrating the Zoology of the R. I. M. S. *Investigater*; 5 plates illustrating the Report of the Medical Congress, and 8 views of the Gohna Lake before and after the breaking of the dam, besides plates illustrating Mr. E. W. Smith's Report on the architecture of Fatehpur-Sikri, and Dr. Führer's Report on the Great Jaina Establishment at Mathura, and 8 plates of coins for the Indian Museum. The annexed map of India has been prepared by drawing the hills on a glass plate and then etching them on a copper plate by heliogravure in the manner described in the Annual Report for 1892-93, while the outline is printed from the hand-engraved plate. The specimen will

illustrate the capabilities of this process for map work in two colours. It is printed dry on special paper prepared as described in the appendix.

656. Some further progress has been made in photo-block printing during the year. While on furlough Mr. Haward learnt the details of what is known as the "enameline" process and is the latest improved method of the kind. Since his return he has worked at it very zealously and introduced a great many improvements in the working, though the enameline process itself is not found to work quite satisfactorily, as explained in the appendix.

657. In the Silver-Printing section a new silver-printing process on plain paper has been introduced which bids fair to be very useful. Further details of this process and of other work performed in the Photographic and Lithographic Office are given in Colonel Waterhouse's report in the appendix.*

MAP RECORD AND ISSUE OFFICE.

Personnel.

Mr. T. A. Pope, Deputy Superintendent, 2nd grade, in charge.
„ F. A. D'Rozario, Head Clerk.
„ H. R. Vallis, Map Curator.
„ J. A. Vallis, Clerk, up to 16th April 1895.
„ W. W. D'Cruz, Clerk, from 17th April 1895, and 15 other clerks.

658. During the year under report the charge of this office has been held by Mr. T. A. Pope.

659. The number and value of maps issued during the year are as follows:—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	102,709	32,577
Ditto to India Office, London	4,401	5,963
Ditto to Agents	1,436	1,783
Ditto to Private individuals	8,732	11,604
Total .	117,278	51,927
Cadastral maps to Government officials	116,948	59,029
GRAND TOTAL .	234,226	1,10,956

660. There has been a decrease both in the number and value of maps issued during the year, owing to smaller demands both by Government officials and private individuals. The number and value of the maps issued during the preceding year were 2,89,915 and ₹1,64,705, respectively, showing in the year under report a decrease of 55,689 in number and ₹53,839 in value.

661. The amount realized from cash sales of maps was ₹23,339, *viz.*, ₹11,604 from private individuals, ₹891 from agents, and ₹10,844 from Government officials, showing a small increase of ₹243 on the cash receipts of the previous year.

662. In the Revenue Section 898 applications were received for extract from original Records of the Revenue Surveys, and 3,775 for certified copies of village plans, tracings and traverses, which were all supplied at a charge of ₹10,726.

* Colonel Waterhouse reports well of all his principal assistants, *viz.*,—Messrs. H. L. Lepage, B. Mackenzie, E. A. LeFranc, D. Deas, Sergeant Vandyke and Mr. E. de Pyvah in the Lithographic, Zincographic and Type Printing Sections; Messrs H. Haward, A. W. Turner, J. Harrold, R. George and L. Lagnier, in the Photographic Sections. Among the junior assistants and apprentices the following are commended:—Messrs. J. B. Mackenzie (who carried on the duties of the Normal Zinc-Printing Section with satisfaction during his father's absence on privilege leave), E. Dowling, S. U. Ravenscroft, C. J. Meade, J. T. Meade, P. Michael, C. Andrews, F. U. Murphy, N. J. Gonsalves, J. Vieux and J. DeSilva. In the Lithographic Drawing Section, Babu Umbica Churn Mukharji, Munshi Abdul Hamid, Abdul Hakim, Babu Dino Nath Das and most of the other draftsmen have done well. In the photographic sections the following native assistants may be specially mentioned as doing good work:—Mahomed Ismail, Habibul Hassain, Abdul Ruhman, Ambica Churn Bhuttacharji, assistant photographers; also Azizur Ruhman, native engraver, and Aghor Nath Sircar, native copperplate printer. In the Correspondence and Accounts section Babu Kanny Lall Sen has continued to conduct the duties of Head Clerk and Accountant very satisfactorily, Babu Kedar Nath Ghose, Gopal Chandra Mukharji, Surja Kumar Banarji, Rajani Kanth Chattarji, and Nogendra Nath Mukharji, native clerks, have also done well.

663. The details of work are given in the following statement, and will be found to correspond closely with those of the preceding year:—

Details.	Number.
Applications received for maps	5,371
Letters issued in reply	3,194
Cash and credit map sale bills	1,654
Invoices and receipts issued for published maps	1,466
Ditto Ditto for cadastral maps	248
Ditto Ditto for extracts from original records	343
Packets, parcels and local despatches	5,673
Ditto received in office	778
Packages despatched by rail and steamer	502
Ditto received ditto ditto	95
Maps coloured for sale and issue	22,577
Ditto for other departments	4,435

A list of the maps and charts published during the year will be found at page 116.*

MATHEMATICAL INSTRUMENT OFFICE.

664. Colonel Rogers continued to hold charge of this office until the 20th March 1895, when he proceeded on furlough for eight months and was relieved by Mr. T. A. Pope, who held charge during the remainder of the year. No other changes have to be recorded in the *personnel* of the office.

Personnel.

Colonel M. W. Rogers, R.E., Assistant Surveyor-General, up to 19th March 1895.
Mr. T. A. Pope, Officiating Assistant Surveyor-General, from 20th March 1895.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker.
„ T. R. Theakston, Assistant Mathematical Instrument Maker.
200 Artificers.

Store Branch.

Mr. M. C. Belletty, Instrument Storekeeper.
Babu Womesh Chunder Chowdhury, Material Storekeeper.
1 packing sircar and 2 packers.

Office Establishment.

Mr. W. Campagnac, Head Clerk.
„ W. R. Tulloch, 2nd clerk.
6 clerks and 3 temporary clerks.

665. The figures in this report refer to the financial year, *i.e.*, from 1st April to 31st March 1895. During this period the number of serviceable instruments received into store was 88,591, and their value ₹3,80,703, while the number of those issued from store was 71,875, valued at ₹2,40,818. In the subjoined statement these figures are compared with those of the preceding year, and it will be seen that, as regards receipts of instruments, there has been an increase in the number though their value is less. The number of instruments issued is also greater, while their value is slightly less. The deficiency in the value both of instruments received and issued is due to the large proportion of low-priced instruments dealt with during the year.

	1893-94.	1894-95.	Increase.	Decrease.
Number of instruments received	75,617	88,591	12,974	.....
Value of ditto ₹	4,24,529	3,80,703	.....	43,826
Number of instruments issued.	63,728	71,875	*8,147	.....
Value of ditto ₹	2,47,111	2,40,818	.....	6,293

From this table it will be seen that the number of serviceable instruments in store has increased by 16,716 and their value by ₹1,39,885.

* Mr. Pope reports that Mr. D'Rozario has conducted his duties satisfactorily, and that Mr. Vallis is again deserving of special commendation. Messrs. D'Cruz and Hazra have also worked well.

666. In the following statement are shown the principal sources from which the serviceable instruments were received:—

Sources of receipt.	Number.	Value.
		₹
From England on indent	24,157	2,35,243
By purchase in the local market	25,564	39,154
Manufactured in workshop	24,064	27,160
Returned to store by public officers . . .	11,693	8,767
From repairable stock after repair . . .	3,065	70,360
From other sources	48	19
Total .	88,591	3,80,703

The number and value of the instruments received from England on indent have decreased, the figures for last year being 27,842 and ₹2,61,103. The decrease is due to the smaller demands made on the office for instruments during the preceding year, whereby the stock at the close of the year was somewhat larger than usual and the indent for instruments for the year under report was consequently smaller.

The value of the instruments purchased in India increased slightly during the year in consequence of the larger number of instruments issued. The number of instruments manufactured in the workshop is greater, but their value is less; these instruments are specified in detail in Table C in the Appendix.

667. In his letter No. 375 P. A., dated 14th March 1895, the Comptroller of India Treasuries objected to the purchase by this office in the local market of certain articles of European manufacture, stating that under Article 98 (K) of the Civil Account Code the special sanction of the Government of India was necessary for purchasing them in India, and requesting that, if any general orders of Government authorizing such purchases existed, a copy might be furnished to him. After some correspondence the case was referred to Government, and a request was made that the present orders on the subject, if not sufficiently clear and explicit as they stand, might be modified in order to obviate the necessity of obtaining sanction from the Government in every case. In November, the Government were pleased to accord the necessary sanction, *vide* letter No. 3258-139-2, dated 20th November 1895, to the Surveyor-General.

668. Amongst other instruments manufactured in the workshop during the year may be mentioned a long-base horizontal range-finder, which has been constructed chiefly from designs furnished by Captain A. Butcher, R.A., Inspector of Gunnery, Bengal, for use in low-lying forts. After a rigorous course of testing by a Committee at Chingree Khal, it was very favourably reported on, and orders have been received to despatch it to England for further trial and report by the Ordnance Committee, previous to its adoption in India. The instrument is of somewhat complicated design, and much credit is due to Mr. Bolton, the Mathematical Instrument Maker, for the skill and pains he brought to bear upon its construction, to which its successful working under trial is largely due.

669. The number of instruments taken from the repairable stock and rendered serviceable for issue is considerably less both in quantity and value than in the preceding year. During the year under report the office has received 9,062 repairable instruments, valued at ₹66,198, against 5,977 instruments, valued at ₹76,899, in the previous year. The total number of instruments from the repairable stock which were rendered serviceable was 3,065 and their value was ₹43,999. These were repaired in the workshop at a cost of ₹26,362, and transferred at an enhanced value to the serviceable stock.

The repairable stock has thus been increased by 5,997 instruments, valued at ₹22,199. This large increase is entirely due (as pointed out in paragraph 719 of the last Annual Report) to the fact that the present workshop establishment is insufficient to deal with the instruments sent in for repairs and re-issue, and at the same time to make any impression on the constantly accumulating stock of repairable instruments returned into store. The subject has recently been brought to the notice of the Government with special reference to the question of levels, which form with theodolites the most important items of the repairable stock, and the arrangements proposed to enable the office to bring these on the serviceable stock will be found in the next paragraph. Similar arrangements should be made, as soon as possible, to enable the office to cope with the large and daily increasing stock of instruments now awaiting repair.

In order that a decision may be arrived at as to the best way of doing this, a committee will be formed who will report on the kinds and numbers of instruments to be repaired and will make proposals as to how they should be dealt with. Application will then be made to Government to sanction any extra establishment that may be required.

670. During the year under review the conversion of levels of obsolete pattern has been proceeded with, and 48 levels, which in their unaltered condition were worth only the price of old metal, were converted to Bolton's reversible pattern, and many of them were issued on the public service. The Government of India having directed (in Revenue and Agricultural Department letter No. 2240 P., dated August 8th, 1895, to the Surveyor-General) that the purchase of levels in England should be discontinued and requirements met by conversion of the old levels in stock until they were exhausted, application has been made for a further grant of ₹220 per month, in addition to the present permanent grant of ₹120, for an extra workshop establishment for this purpose. There are some hundreds of old levels in stock, and others are constantly being returned, so that the work of converting them may go on for several years to come, and a considerable saving will be effected thereby.

671. The number of indents complied with during the year was 1,148, as against 1,244 during the preceding year. They were of the usual description, the two largest being for instruments for the Kotri-Rohri and Assam-Bengal Connection railway surveys.

672. In Table A in the Appendix are shown the amounts debited against the various offices and departments for instruments and repairs to instruments during the year. The total value of the issues and repairs on book debit was ₹223,699, being ₹4,249 more than in the previous year. This amount includes the value of instruments purchased locally and paid for out of the extra-departmental grant of ₹45,000, of which only ₹31,702 was expended. The credits for instruments returned into store amounted to ₹75,855, which is considerably less than in the previous year. The grand total of supplies, including cash sales, is ₹2,57,551, or very slightly more than last year.

673. The number of principal instruments repaired in the workshop is 3,514, or about 700 in excess of last year. The total number of instruments of all kinds repaired amounts to 4,407, or 466 in excess of last year.

674. For some time past the want has been felt of some place of shelter for the cases containing instruments received from England and elsewhere while being unpacked, for which there is no room in the main building, and this work has hitherto been carried on in the open air in all weathers. A sum of ₹2,550 was included in the estimates for 1894-95 for the erection of a light iron shed in the office compound for this purpose. The work was commenced in July 1895, and was nearly completed at the close of the year. The shed will also serve to accommodate the workmen engaged in making packing cases and for the storage of coal, the provision for which has hitherto been insufficient.

675. Reviewing briefly the outturn of work of the office during the year, it will be seen that a larger number of instruments of all kinds were issued than in any previous year. As regards repairs to instruments, which forms the principal duty of the workshop, the outturn is also in excess of any previous year; though the total value of the work done of this description is rather less than last year owing to the fact that comparatively little could be done towards repairing instruments for stock, as pointed out in paragraph 669, the establishment being almost entirely occupied in current repairs. Apart from this, which

is due to the inadequacy of the establishment, the work of the year may be regarded as highly satisfactory.

676. The profit and loss account of the workshop will be found in the Appendix. An apparent profit of R1,122 is shown as the result of the year's work, which indicates that the prices charged for work done have been carefully adjusted so as to cover the expenditure without leaving an undue margin of profit.*

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

677. The general direction of this office remained in the hands of Major St. G. C. Gore, R.E., who was promoted to Lieut.-Colonel from the 2nd July 1895.

Personnel.

Superintendence.

Lieut.-Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys.
Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 1st grade, in charge Computing Party.

(1) *Computing Section.*

Mr. H. W. Peychers, Extra Assistant Superintendent, 2nd grade.
Mr. A. D. Christie, Extra Assistant Superintendent, 3rd grade.
Babu Amba Pershad and 8 other computers, 2 copyists, and 2 writers.

(2) *Printing Section.*

Mr. B. V. Hughes, Printer up to 10th April 1895.
9 compositors and 2 distributors.

(3) *Photo-zincographic Section.*

Mr. J. S. Manuel, Assistant Zincographer up to 30th April 1895, and Zincographer from 1st May 1895.
Mr. G. A. LeFranc, Assistant Zincographer, Officiating Zincographer from 12th August 1895.
2 Photographers, 6 plate correctors, 5 retouchers, 4 zinc printers, 12 assistant zinc printers, 1 accountant, 1 store-keeper, and 1 despatcher.

(4) *Correspondence Section.*

Mr. J. Burbridge, Head Clerk, and 3 clerks.

(5) *Stores, Workshops, and Observatories Section.*

1 writer, 1 head artificer, and 3 artificers.

(6) *Drawing Section.*

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 4th grade.
4 draftsmen, 1 sub-surveyor, 3 assistant and 8 apprentice draftsmen.

(7) *Solar Photographic Section.*

Mr. C. F. Guthrie, Assistant Solar Photographer.

678. During the year the alterations to the office buildings, mentioned in para. 730 of the last Report, were commenced and almost finished. So much of the building was demolished that great difficulty was experienced in carrying on the work, and considerable credit is due to the heads of the various sections for the manner in which they adapted their requirements to the reduced space of accommodation. A short account of some of the changes will be found in the appendix.

679. The office is divided into the following sections:—

(1) Computing.
(2) Printing.
(3) Photo-zincographic.
(4) Correspondence.
(5) Stores, Workshops, and Observatories.
(6) Drawing.
(7) Solar Photography.

(1) *Computing Section.*

680. In addition to the five instalments of field records which were received during the year and stored as usual, a great amount of work was entailed on this section in removing and arranging the field records and library books consequent on the dismantling of the office buildings as noted above. In all, fifteen requisitions for data were complied with; among these may be noted those for the Chitral Relief Force, the Pamir Delimitation Commission, and the Anglo-Afghan Boundary Commission. The computations for the

* Mr. Pope reports that Mr. Bolton, the Mathematical Instrument Maker, has well sustained his reputation for intelligence and zeal. He has managed the large workshop establishment most efficiently, and his personal experience and skill in all the complicated operations conducted therein are of the highest value to the Government. Mr. Theakston, Assistant Mathematical Instrument Maker, has also displayed much intelligence, and has proved himself capable of performing with credit any duty that may be required of him.

In the Correspondence and Store branches, Messrs, Campagnac, Belletty and Tulloch again deserve commendation.

Among the Native assistants, Babus Durga Churn Ghose, Gosain Das Roy, Shib Chunder Ghose and Narain Chunder Banerjee, Clerks, and Womesh Chunder Chowdhury, Material Storekeeper, are deserving of special mention.

synoptical volume of the North-East Longitudinal Series were proceeded with, and the Municipality survey traverses for the towns of Gurgaon and Shona were reduced. The preparation of press copy and examination of press proofs were carried on as hitherto; the outturn of work from these is given in the next section. The charts for the synoptical volume of the Kathiawar Meridional Series and those for the spirit-levelled heights pamphlets for Karachi and its neighbourhood, and No. 8 Central Provinces and Orissa, were examined and passed through the press. The work in connection with the protection of survey stations was carried on as usual. Twenty-one districts out of 346 omitted to submit reports. Thirty-eight candidates for the Provincial Service of the Survey of India were examined. The meteorological observations were conducted as usual.

(2) *Printing Section.*

681. The following is the progress made:—

(*a*) Pamphlet of spirit-levelled heights, Karachi and its neighbourhood, published.
(*b*) Pamphlet of spirit-levelled heights, No. 8 Central Provinces and Orissa, published.
(*c*) Imperial Forest School Calendar for 1895, finished.
(*d*) Synoptical volume of the Great Arc Meridional Series, Sections 8° to 18°, about three-fourths completed.
(*e*) Tidal volume, 36 pages printed.

In addition to the above, a large amount of work was done in printing the letter-press for charts, headings and foot-notes for maps, and professional forms for the Department.

(3) *Photo-zincographic Section.*

682. In January the new plant was received, and since then all arrears have been cleared off. In March and April, the section had to be worked overtime to meet the sudden demand for the maps required by the Chitral Relief Force, for which 6,680 pulls were made in 17 days.

(4) *Correspondence Section.*

683. This has been conducted as usual.

(5) *Stores, Workshops, and Observatories Section.*

684. Some extra work was thrown on this section in equipping the survey detachments which accompanied the Chitral Relief Force, the Pamir Delimitation Commission, and the Anglo-Afghan Boundary Commission. In the observatory some experiments were commenced to determine the amount of variation in the values of micrometer screws owing to the variation of temperature.

(6) *Drawing Section.*

685. The difficulty of obtaining efficient draftsmen to complete the sanctioned strength of this section, until the close of the year, prevented much progress being made in compilations. One sheet on the scale of 1 inch to 16 miles was taken up and the outlining and printing completed. An explorer's route was compiled and published, and the compilation of three level sheets, which are in great demand, is in progress. The outturn, which is detailed in the appendix, includes the following:—

Two maps compiled for the Quarter Master General; two maps completed for the Foreign Office; 36 field sheets of Gurgaon and 12 of the town and environs of Shona plotted and supplied to the Deputy Commissioner of Gurgaon; two standard sheets of Gujarat corrected for the press; a triangulation chart for a synoptical volume was completed and a second is in progress; two diagrams for the tidal volume were completed and twenty-five are in hand; one thousand seven hundred and seventeen maps coloured.

(7) *Solar Photographic Section.*

686. The work of this section was continued as usual.

687. The offices were inspected in May 1895 by the Surveyor-General, who was quite satisfied with the working of the several sections.*

III.—DRAWING OFFICE, SIMLA.

688. This office remained under the nominal superintendence of Colonel Holdich, but as usual, the district charge devolved upon Mr. G. W. E. Atkinson during the greater part of the year, or for 8½ months in all, while Colonel Holdich was engaged with the Asmar Khyber and Pamir boundary delimitation detachments.

Personnel.

Colonel T.'H. Holdich, C.B., C.I.E., R.E., Superintendent, 1st grade, in charge.
Mr. G. W. E. Atkinson, Officiating Assistant Superintendent, 1st grade.
„ T. H. Rendell, Extra Assistant Superintendent, 4th grade.
„ J. Cornelius, Extra Assistant Superintendent, 5th grade.
„ F. E. Warde, Sub-Assistant Superintendent, 1st grade.
„ F. Rozario, Surveyor.
„ H. Sindon, Draftsman.
Munshi Jafir Khan, Draftsman.
Mr. W. Manly, Draftsman, and three other draftsmen.

689. The principal work of tho office has been the preparation of second editions of the 8-mile sheets of the North-West Trans-Frontier and South-West Asia Series, by incorporating with the first editions the materials furnished by officers of the Intelligence Branch and others, which have been accumulating in the office for some years past. Of these sheets no less than twelve have been completed and sent to press during the year, while several others were in various stages of progress.

690. Another important undertaking upon which the office was engaged during the year was the large map of Persia in six sheets, on the scale of 16 miles =1 inch. Very satisfactory progress was made with this map, four of the sheets (which are printed in two colours) being practically completed and the other two taken in hand.

691. In addition to the maps mentioned above a large amount of miscellaneous work was performed and several important pieces of work were executed for the Foreign Department, and the Quarter Master General's Department.†

IV.—FOREST SURVEY BRANCH OFFICE, DEHRA DUN.

692. The Head-quarters Offices of the Forest Survey Branch which are located at Dehra Dun, have, throughout the year, been under the direct supervision of Mr. W. H. Reynolds, and the following branches of work have been dealt with :—

(1) Correspondence, accounts and Forest Department map records.
(2) Final computations of the several field detachments and areas.
(3) Compiling and drawing of special maps for the Forest Department.
(4) Training of surveyors for forest works.
(5) Other miscellaneous work for the Forest Department.

693. The provincial map records of the forests in the several provinces under the Government of India as well as Madras, have been posted up, and all new tracts gazetted as state forests have been located on the maps. The alterations also of forest boundaries that have been notified from time to time in the several provincial gazettes have received attention and the map records have been revised accordingly.

* Mr. Eccles reports very highly of the work done by his assistants, Messrs. Peychers, Christie, McA'Fee, Hughes, Manuel, LeFranc and Guthrie, and speaks well of the computers.
The Superintendent reports very favourably of the assistance rendered him by Mr. Christie and Mr. McA'Fee.
The Correspondence Office has carried on its work satisfactorily during the year.

† Mr. Atkinson speaks highly of the work done by Mr. Cornelius, and mentions also Messrs. Warde Sindon, Rozario, and Manly and Munshi Jafir Khan, all of whom are said to have worked throughout the year with cheerfulness and assiduity.

694. The alphabetical lists and other tabulated statements connected with the forest map records have been revised, but these records are constantly undergoing changes which are due chiefly to the interior boundaries of the forests being altered from time to time for the purposes of better administration, and hence these records require constant attention.

695. For forest working plans and other purposes in the several provinces under the Government of India numerous areas were deducted, comprising chiefly areas for exchanges of land, areas of different classes of forests, areas of interior sub-divisions of reserved forests, such as blocks and compartments, etc. In all 234 sheets on the 4-inch scale were dealt with.

696. For the several provincial Forest Departments, a vast amount of mapping has been got out of hand; 15 special maps on various scales were published, 4 are in the press and 18 are in progress, and of the 4-inch standard maps of the forest tracts surveyed by the Forest Survey Branch 127 sheets have been published, 45 are in the press and 118 sheets are in different stages of completion.

697. A large quantity of miscellaneous work was also done for various district and forest officers, included in which is the colouring of 1,931 printed maps and the addition of the forest growth records to 67 published sheets; 1,845 printed maps were cut up and mounted in book form and 67 tracings were prepared.

698. The Surveyor-General inspected the Forest Survey Office in April 1895.*

* Mr. Reynolds reports that Mr. Descubes deserves great praise for his constant attention to and the great care with which he does his work at the Head-quarters Office.

Babus Badri Dutt and Bimala Charan Shome are specially mentioned as good computers, and Tulsi Ram, Jadu Nath and Mahomed Hussain as excellent draftsmen.

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1894-95.

Title.	Scale.	Number of sheets.	Remarks.
Atlas of India.	In. M.		
Sheet No. 7	1=4	1	With corrections to 1885.
Sheets Nos. 47, 61, 107 and 120	1=4	4	With additions to 1894.
Sheet No. 65	1=4	1	With additions to 1895.
Sheet No. 112	1=4	1	With additions to 1893.
Sheets Nos. 2S.E., 70S.E.; 71N.W. and 129N.E.	1=4	4	With additions to 1892.
Sheets Nos. 15S.W., 49N.E.; 67S.W.; 67S.E.; 72S.E., 91N.W. and 91S.W.	1=4	7	With additions to 1893.
Sheets Nos. 23S.E.; 66N.E.; 66N.W.; 70S.W.; 125N.E.; 125N.W., and 131N.W.	1=4	7	With additions to 1894.
Sheet No. 31N.W.	1=4	1	With additions and corrections to 1894.
Sheets Nos. 31N.E.; 48N.W.; 60S.E.; 87N.E., and 87S.E.	1=4	5	New publications.
Sheets Nos. 34S.W. and 87N.W.	1=4	2	With additions to 1890.
Sheet No. 59N.W.	1=4	1	Preliminary edition. New publication.
Sheets Nos. 67S.E., 105N.E. and 126S.W.	1=4	3	With additions to 1895.
Sheet No. 90N.E.	1=4	1	With additions to 1891.
Sheet No. 91S.E.	1=4	1	With additions to 1888.
Sheet No. 105N.W.	1=4	1	With corrections to 1892.
Sheet No. 124S.E.	1=4	1	With corrections to 1893.
General Maps.			
India (with hills)	1=64	4	Engraved. With additions to railways to 1895.
India showing Provincial and District boundaries (Skeleton)	1=64	2	
India (without hills)	1=256	1	Engraved.
Provincial Maps.			
Sind Sheets Nos. 1 and 2	1=4	2	With additions to railways to 1895.
Assam (Skeleton)	1=16	1	With additions and corrections to May 1895.
Bengal, Behar, Orissa, and Chota Nagpur (without hills)	1=16	2	
His Highness the Nizam's Dominions, including the Assigned Districts of Berar	1=16	2	With additions and corrections to April 1892.
Punjab and Kashmir (Skeleton)	1=16	4	With additions and corrections to 1894.
Upper Burma (with hills)	1=16	2	2nd edition.
Upper Burma (Skeleton)	1=16	2	2nd edition.
Bombay Presidency (exclusive of Sind)	1=32	1	With additions to railways to 1894.
Central Provinces	1=32	1	With additions to railways to March 1895.
North-West Provinces and Oudh	1=32	1	With additions to March 1895.
Bengal, Behar, Orissa, and Chota Nagpur	1=64	1	

Title.	Scale.	Number of sheets.	Remarks.
District Maps.	In. M.		
Almorah (N.-W. P.)	1=2	6	
Gorakhpore (N.-W. P.)	1=2	6	
Burdwan (Bengal)	1=4	1	With additions and corrections to January 1895.
Durbhanga (Bengal)	1=4	1	With additions and corrections to roads and boundaries to March 1895.
Kamrup (Assam)	1=4	1	With additions and corrections to December 1893.
Lohardugga (Bengal)	1=4	1	
Malda (Bengal)	1=4	1	With additions of roads, and corrections to boundaries to May 1895.
Mymensing (Bengal)	1=4	1	With additions and corrections to February 1894.
Sonthal Parganas (Bengal)	1=4	1	With additions and corrections to July 1894.
Sylhet (Assam)	1=4	1	With additions and corrections to March 1894.
Standard Maps.			
Aden.			
Sheets Nos. 1, 2 and 4	1=2	3	2nd editions.
Sheet No. 5	1=2	1	
Assam.			
Goalpara District, Sheets Nos. 1 $\frac{N.E.}{2}$; 1 $\frac{N.E.}{4}$; 1 $\frac{S.E.}{2}$; 2 $\frac{N.E.}{4}$ and 9 $\frac{W.}{3}$ (in one); 2 $\frac{S.E.}{2}$ and 9 $\frac{S.W.}{1}$ (in one); 7 $\frac{N.E.}{4}$; 7 $\frac{S.W.}{4}$ and part of $\frac{S.W.}{2}$; (in one); 7 $\frac{S.E.}{1}$; 7 $\frac{S.E.}{2}$; 7 $\frac{S.E.}{3}$; 7 $\frac{S.E.}{4}$; 8 $\frac{N.W.}{1}$; 8 $\frac{N.W.}{2}$; 8 $\frac{N.W}{3}$; 8 $\frac{N.W.}{4}$; 8 $\frac{N.E.}{1}$; 8 $\frac{N.E.}{2}$; 8 $\frac{N.E.}{3}$; 8 $\frac{N.E.}{4}$; 8 $\frac{S.W.}{1}$; 8 $\frac{S.W.}{2}$; 8 $\frac{S.W.}{3}$; 8 $\frac{S.W.}{4}$ 8 $\frac{S.E.}{1}$; 8 $\frac{S.E.}{2}$; 8 $\frac{S.E.}{3}$; and 9 $\frac{N.E.}{1}$ (in one); 8 $\frac{S.E}{4}$; and 17 $\frac{N.W.}{1 \text{ and } 3}$	4=1	28	
Bengal.			
Sheets Nos. 207, 223, 224, 292, 315, 337, 338, 359, 375, 376, 378 and 388	1=1	12	
Bombay.			
Sheets Nos. 246 N.E. and 246 S.E.	2=1	2	
Sheets Nos. 159, 160, 174, 175, 206, 207, 224, 241, 242, 303 and 308	1=1	11	
Sheet No. 167	1=1	1	Special edition showing Forests.
Sheet No. 199	1=1	1	With corrections to December 1894.
Sheet No. 227	1=1	1	With additions and corrections to September 1894.
Sheet No. 228	1=1	1	With additions and corrections to January 1895.
Sheet No. 270	1=1	1	With additions and corrections to May 1895.

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*continued.*	In. M.		
Burma (Lower).			
Toungoo District (Karen Hill Tracts.)—Sheets Nos. 271 N.E./2; 271 S.E./4; 271 N.E./4; 318 S.W./3; 271 —/2; and 318 S.W./1 (in one)	4=1	5	
Toungoo District—Sheets Nos. 224 N.E./1; 224 N.E./2; 224 N.E./3; 224 N.E./4; 224 S.E./2; 224 S.E./4; 225 S.E./2; 225 N.E./2; 271 N.E./1; 271 N.E./3; 271 N.W./1; 271 N.W./2; 271 N.W./3; 271 N.W./4; 271 S.E./1; 271 S.E./3; 271 S.W./2; 271 W./4; 272 N.W./1; 272 N.W./2; 272 N.W./3; 272 N.W./4; 272 S.W./1; 273 N.W./1; and 319 N.W./1; and 272 N.E./2 (in one)	4=1	25	
Sheets Nos. 374, 375, 376, 563, 570, 571, 579, 580 and 581	1=1	9	
Sheet No. 231	1=1	1	With corrections to 1894.
Sheet No. 234	1=1	1	2nd edition.
Burma (Upper).			
Salween Ataran—Sheets Nos. 475 N.W./2 and 4; and 475 N.E./1 and 3; (in one); 475 S.E./1; 475 S.E./3; 475 S.E./4; 476 N.E./1; 476 N.E./2; 476 N.E./4; 476 S.E./2; 548 N.W./1 and 3; and 548 S.W./1	4=1	10	
Sheets Nos. 258 and 313	1=1	2	
Central India and Rajputana.			
Sheets Nos. 396, 409, 421, 429, 431, 480, and 482	1=1	7	
Central Provinces.			
Hoshangabad District—Sheets Nos. 34 S.E./1; 34 S.E./2; 34 S.E./4; 34 S.W./2; 35 N.W./3; 35 S.W./1; 34 N.E./2 and 4; and 50 N.W./1 and 3 (in one)	4=1	7	
Hoshangabad and Chindwara Districts—Sheets Nos. 35 N.W./4; 35 N.E./1; and N.E./2 (in one); and 35 N.E./3 and N.E./4 (in one)	4=1	3	
Nimar District—Sheets Nos. 5 N.E./4; 5 S.E./2; 5 S.E./4; 5 S.E./1 and S.W./2 (in one); 5 S.W./4; 6 N.E./2; 6 N.E./3; 6 N.E./4; 6 S.W./4; 11 S.W./2; 11 S.W./3; 11 S.W./4; and 12 S.E./4	4=1	13	
Bhandara District—Sheets Nos. 92 N.E./4; 92 S.W./1; 92 S.W./2; 92 S.W./3; 92 S.W./4; 92 S.E./3; and part of S.E./4; 93 N.W./2	4=1	7	

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*continued.*	In. M.		
Central Provinces—contd.			
Jubbulpore District—Sheets Nos. 84 S.E./3 and 4; and 85 N.E./1 and 2 (in one); 86 S.W./4; 86 S.E./3; 87 N.W./2; 87 N.W./4; 87 N.E./1; 87 N.E./2; 87 N.E./3; 87 N.E./4; 87 S.E./1; 87 S.E./2; 105 N.W./4; 105 S.W./1; 105 S.W./2; 105 S.W./3; 105 S.W./4; 105 S.E./1 and 3; 106 N.W./2; 106 N.E./1 and 2; 106 S.W./2; and part of S.W./1 (in one); 106 S.E./2; 107 S.E./4; 108 N.E./1; 108 S.W./1; and S.W./2 (in one); 108 S.W./3; 108 S.W./4; 108 S.E./1; 108 S.E./3; 108 S.E./4; 109 N.W./1; 109 N.W./2; 109 N.W./3; 109 N.W./4; 109 N.E./1; 109 N.E./2 and 4; 109 N.E./3; 109 S.W./1; 109 S.W./3; 109 S.W./4; 109 S.E./1; 128 S.E./2; 128 S.E./3; and part of S.E./1 (in one); 128 S.E./4; 129 N.W./4; 129 S.W./1; 129 S.W./2; 129 S.W./3; 129 S.W./4; 129 S.E./1; and part of N.E./3 (in one); 129 S.E./2; 129 S.E./3; and 130 N.E./1 (in one); 129 S.E./4; 130 N.W./3; 130 N.E./2; 130 N.E./4; 130 S.W./1; and part of S.W./2 (in one); 131 N.W./1; 131 N.W./3; and 131 S.W./1 and 3 . .	4=1	59	
Raipur District—Sheets Nos. 187 N.E./2; 187 S.W./2; 188 N.E./4; 188 S.E./3; 188 S.E./4; 207 S.W./1; and 207 S.W./3	4=1	7	
Hyderabad (Deccan).			
Sheets Nos. 168 and 169	1=1	2	Railways corrected to April 1892.
Golconda Circar: Sheet No. 150	1=1	1	With additions to Railways to April 1892.
Khamamet Circar: Sheet No. 211	1=1	1	With additions to 1895.
Sheets Nos. 101, 102, 103, 125, 126 and 127 (in one) . .	1=2	1	Railways corrected to September 1894.
Indus Riverain.			
Sheets Nos. 40, 59, 78, 79, 80, 98, 99, and 60 and portion of 81 (in one)	1=1	8	
Madras.			
Sheet No. 152	1=1	1	
North-Western Provinces and Oudh.			
Naini Tal District—Sheets Nos. 46 S.E./2; 46 N.E./2; and N.E./4 (in one); 63 S.W./1; 63 S.W./2; 63 S.W./3; 63 S.W./4; 63 N.E./3; 63 N.W./4; 63 S.E./1; 63 S.E./3; 63 N.W./1; and N.W./3 (in one); 64 N.E./1; 64 N.E./2; 64 N.E./3; 64 N.E./4; 64 S.E./1, 2 and 4; 250 S.W./3; 251 N.W./1; 251 N.W./2; 251 N.W./3; 251 N.W./4; 251 S.W./1; 251 S.W./2; 251 S.W./3; 251 S.W./4; 251 S.E./1; and 251 S.E./3 .	4=1	27	
Pilibhit District—Sheets Nos. 82 N.E./2 and 4; 82 S.E./2 and 98 S.W./1 (in one); 82 S.E./4 and 98 S.W./3 (in one); 97 S.W./3; 98 N.W./1; 98 N.W./2; 98 N.W./3; 98 N.W./4; 98 S.W./2 and S.E./1 (in one);	4=1	10	
98 S.E./3 and 99 N.E./1 (in one);	4=1	1	

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*continued.*	In. M.		
North-Western Provinces and Oudh—contd.			
Kheri District—Sheet No. 100 N.E./3 and 4			
Sheets Nos. 46; 47; 48; 49; 50; 64; 65; 67; 84; 99; 100 and 178	1=1	12	2nd edition.
Sheets Nos. 66; 81; 82; 250 and 251	1=1	5	
Sheets Nos. 68 and 83	1=1	2	With corrections to November 1894.
Punjab.			
Bashahr State—Sheets Nos. 331 S.W./2; 331 S.W./4; 331 S.E./2; 331 S.E./3; 331 S.E./4; 332 N.E./1; 332 N.E./3; 332 S.E./1; 333 N.W./2; 346 —/3; 346 S.E./4 and 352 S.W./3 (in one); and 347 N.E./3	4=1	12	
Gurdaspur District—Sheets Nos. 246 N.E./1; 246 —/2 and 246 N.W./4	4=1	3	
Kangra District—Sheets Nos. 264 S.E./4; 285 N.W./4; 285 S.W./1; 285 S.W./3; 285 S.E./2; 286 N.W./2 and 309 S.E./4	4=1	7	Preliminary issue on exaggerated scale for local purposes.
Sheets Nos. 265 N.E./1; 265 N.E./4; 285 N.W./1; 285 N.W./2; 285 N.W./3; 316 N.E./1 and 2; 332 N.W./1; 332 N.W./2; 332 N.W./3 and 332 S.W./1	4=1	10	
Kangra and Hoshiarpur Districts—Sheet No. 265 S.E./3	4=1	1	
Kangra District and Mandi State—Sheet No. 285 S.W./4	4=1	1	
Umballa District, Simla Hill States and Patiala State—Sheet No. 313 N.W./1	4=1	1	
Simla District—Sheet No. 332 S.W./3	4=1	1	
Kangra District—Sheet No. 290 N.E.	2=1	1	
Umballa and Simla Hill States—Sheets Nos. 313 S.E. and 314 N.E.	2=1	2	
Simla Hill States, etc.—Sheet No. 311 N.W.	2=1	1	
Simla District, Simla Hill States, and Patiala State—Sheet No. 312 N.W.	2=1	1	
Umballa District, Patiala and Kalsia States—Sheet No. 291 N.E.	2=1	1	Preliminary edition.
Sheet No. 6 (Peshawar Series)	1=1	1	With additions and corrections to January 1895.
Sheet No. 243	1=1	1	With additions and corrections to April 1895.
Sheet No. 260	1=1	1	With corrections to 1895.
Sheets Nos. 284, 285, 306 and 374 (parts of)	1=1	1	
North-Eastern Frontier.			
Sheet No. 15 N.E.	1=4	1	3rd edition.
Sheet No. 15 S.E.	1=4	1	6th edition.
Sheet No. 15 S.W. (part of)	1=4	1	
Sheet No. 15 S.W.	1=4	1	3rd edition, with correction to boundaries to November 1894.
Sheet No. 15	1=8	1	
South Eastern Frontier.			
Sheet No. 1 N.E.	1=4	1	6th edition.
Sheet No. 1 N.W.	1=4	1	4th edition.
Sheet No. 2 S.E.	1=4	1	4th edition, with corrections to boundaries to 1894.
Sheet No. 2 S.W.	1=4	1	
Sheet No. 5 S.E.	1=4	1	4th edition.
Sheet No. 6 N.W.	1=4	1	7th edition.
Sheet No. 3 A.	1=8	1	2nd edition.

Title.	Scale.	Number of Sheets.	Remarks.
Plans of Cities and Cantonments.	In. M.		
Calcutta—Sheets Nos. M3, M4, M6, N2, N5, N6, N7, N8, O1, O2, O3, O5, O6, O7, O8, O9, O10, P2, P4, P5, P6, P7, P9, P10, P11, Q1, Q2, Q3, Q5, Q9, Q12, Q15, R2, R3, R4, R5, R6, R7, R8, R9, R10, R12, R16, S6, S7, S8, S9, S16, T5, T6, and T10	105·6=1	51	
Kalka Town Survey showing frontage of the houses along the principal roads	176=1	5	
Mysore	12=1	6	With additions to 1894.
Belgaum City and Environs	8=1	2	
Rawalpindi and Environs	2=1	2	
Index Maps.			
Standard sheets of Bombay Presidency No. 2	...	1	With additions and corrections to 1894.
Forest Surveys in Lalitpur Range	1=8	1	
Forest Surveys in Chamba States	1=8	1	
Forest Surveys in Saugor Division	1=8	1	
Forest Surveys in Bahraich, Gonda and Gorakhpur Divisions	1=16	1	
Survey operations in Himalayas shewing sheets published, on 4-inch scale	1=20	2	
Survey operations in Himalayas shewing sheets published, on 2-inch scale	1=20	1	
Forest Surveys in Central Provinces, Damoh District	1=32	1	
Survey operations in Madras, Sheet No. 1	1=32	1	
Survey operations in Madras, Sheet No. 2	1=48	1	
Standard Sheets of Madras, Sheets Nos. 1 and 2	...	2	With additions and corrections to 1894.
Standard Sheets of Sindh (Bombay Presidency), No. 1	...	1	With additions and corrections to 1894.
Standard Sheets, of His Highness the Nizam's Dominions and Assigned Districts of Berar	...	1	With additions and corrections to 1894.
Statistical Maps.			
Telegraph Map of India	1=32	6	
Railway Map of India	1=48	4	Brought up to March 1895.
India showing Railways	1=80	1	With corrections to 31st March 1895.
Administration Report Maps.			
Cuttack	1=8	1	
Darjeeling	1=8	1	
Ghazipur	1=8	1	
Gujrat	1=8	1	
Hooghly	1=8	1	
Howrah	1=8	1	
Jaunpur	1=8	1	
Jubbulpore	1=8	1	
Khulna	1=8	1	
Midnapore	1=8	1	
Monghyr	1=8	1	
Nadia	1=8	1	
Noakhally	1=8	1	
Patna	1=8	1	
Shahabad	1=8	1	
Sialkot	1=8	1	
Sultanpore	1=8	1	
24-Parganas	1=8	1	
Umballa	1=8	1	
Unao	1=8	1	
Palamau	1=12	1	
Muzaffargarh	1=16	1	
Punjab and Surrounding Countries (skeleton)	1=32	1	
Miscellaneous.			
Karor Plateau, Rawalpindi District	12=1	1	
Disputed boundary between Sind and the Bahawalpur State; Sheets Nos. 98S.E., 98S.W., 99N.E., 99N.W., 99S.E., 115N.W., and 115S.W.	2=1	7	
Coal Tracts, Lit-Konbin to Male, Shwebo District	2=1	2	
Waziristan	1=2	2	
Lansdowne Forest Reserve, Garhwal District, Sheets 1 and 2	4=1	2	
Conventional signs, to be used on Topographical maps	...	1	(In 2 parts).

Title.	Scale.	Number of Sheets.	Remarks.
Miscellaneous—*contd.*	In. M.		
Palni Hills, Shola Reserved Forests, Periyakulam Taluk, Madura District, Madras	4=1	1	
Palni Hills, Shola Reserved Forests, Periyakulam Taluk, Madura District, Madras	4=1	3	
No. 9, Ambur Drug Reserved Forest, Gudiyattam Taluk, North Arcot District, Madras	4=1	1	
No. 11, Basivi Reddipalle Reserved Forest, Palmaner Taluk, North Arcot District, Madras	4=1	1	
Nos. 4 and 7 to 13, Kalrayan Hills Reserved Forests, Salem District, Madras	4=1	8	
No. 90, Kanjamalai Reserved Forests, Salem Taluk, Salem District, Madras	4=1	1	
No. 12, Morthana Reserved Forests, Palmaner and Gudiyattam Taluks, North Arcot District, Madras	4=1	2	
No. 10, Musili Madagu Reserved Forest, Palmaner Taluk, North Arcot District, Madras	4=1	1	
No. 13, Naikeneri Reserved Forest, Palmaner and Gudiyattam Taluks, North Arcot District, Madras	4=1	2	
Nos. 50 and 140, Cuvampatti and Puvampatti extension Reserved Forests, Uttankarai Taluk, Salem District, Madras	4=1	1	
No. 14, Peddur Reserved Forest, Palmaner Taluk, North Arcot District, Madras	4=1	2	
Nos. 75 and 78, Pakkanadu and Vanavasi Reserved Forests, Teruchencod and Salem Taluks, Salem District, Madras	4=1	2	
Palni Hills, Shola Reserved Forests, Periyakulam Taluk, Madura District, Madras	4=1	1	
Palni Hills, Shola Reserved Forests, Periyakulam Taluk, Madura District, Madras	4=1	1	
Nos. 79 and 80, Ramasamimalai and Gundakal Reserved Forests, Salem Taluk, Salem District, Madras	4=1	1	
No. 76, Suriyamalai Reserved Forests, Teruchencod Taluk, Salem District, Madras	4=1	1	
Nos. 110, 81 and 57, Yelathur Manukondamalai, Lokur Reserved Forests, Salem Taluk, Salem District, Madras	4=1	2	
Nos. 1, 89, and 122, Mallur Bathamalai Pudupatti Reserved Forests, Salem Taluk, Salem District, Madras	4=1	3	
No. 87, Godumalai Reserved Forest, Salem Taluk, Salem District, Madras	4=1	1	
No. 88, Jalluthu Reserved Forests, Salem Taluk, Salem District, Madras	4=1	2	
No. 75, Poyapatti Reserved Forests, Uttankarai Taluk, Salem District, Madras	4=1	1	
Route map for the Western Himalayas, Kashmir, Punjab and Northern India, with portions of Afghanistan, Baluchistan, etc.	1=32	1	
Map shewing the scene of operations of the Chitral Relief Force	1=24	1	
Ramgarh Range, Dera Dun District	2=1	1	
Khano Forest working circle	2=1	1	
Ganges Range	2=1	1	
Tirsal Range	2=1	1	
Malhan Range	2=1	1	
Jamna Range	2=1	1	
Nageidh working circle	2=1	1	
Map of Melghat Taluka, Sheets Nos. 1, 2 and 3	1=1	3	
Kabaung working circle	1=1	1	
Bandoung working circle	1=1	1	
Topographical symbols for Imperial Forest School	1=1	1	
Tables shewing the progress of Forest conservancy in the Duchy of Saxe-Coburg-Gotha during 11 years	...	1	
Tables shewing the condition of Forests in Saxe-Coburg-Gotha in 1880 and 1893	...	1	
Triangulation Charts.			
Tidal and Levelling operations of the Survey of India Department shewing approximate Co-tidal Lines 1858–95, on Mercator's projection	...	1	
No. 45, of the Coast Triangulation, Indus Delta between Karachi and Sisa creek with pamphlet	1=2	1	Preliminary.
Punjab Survey, Sheets Nos. 290 and 313	1=2	2	
Mandalay Meridional Series No. 5	1=4	1	Preliminary edition.
Bashahr Forest Triangulation Sheet No. 332	1=1	1	

APPENDIX

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

BURMA AND THE INDUS DELTA COAST.

Statement of the outturn of work executed by No. 24 Party during Season 1894-95.

UPPER BURMA TRIANGULATION.

Description of details.	Principal Triangulation.		
	Lt. Burn.	Lt. Pilcher.	Totals and means.
Number of stations newly fixed	10	2	12
„ „ figures completed	2	1	3
Length of series in miles completed	46	20	66
„ „ approximate series in miles in advance	80	40	120
Area of triangulation in square miles	805	553	1358
Average triangular error in seconds	0″·43	1″·49	0″·96
Astronomical azimuth of verification	...	1	1
Average probable error of angles in seconds	0″·37	0″·57	0″·47
Number of principal stations selected in advance	5	2	7
„ „ station platforms constructed	10	2	12
„ „ stations placed under official protection	5	2	7
„ „ „ the elements of which have been computed	5	2	7
Area embraced by the triangulation to points exterior to main triangulation in square miles	127	280	407
Number of secondary points fixed	1	1	2
„ „ stations and points the heights of which have been determined	6	4	10
Number of miles of rays and paths cleared	100	75	175
„ „ preliminary charts of triangulation	1	1	2
„ „ hill tops cleared of jungle	9	2	11
Mean co-efficient of refraction	0·068	0·062	0·065

Table showing results of astronomical azimuths observed on the Mandalay Meridional Series.

Place.	Year.	Observer.	Instrument used.	Stars observed.	E. Elongation.	W. Elongation.	Difference.	Mean.	Astro minus Geodetic.	Latitude.
Myayabengkyo	1889	Mr. Eccles	No. I 12″	51 Cephei δ Ursæ minoris	o ′ ″ 169-33-43·301	40·″987	2·″314	42·″144	—5·″456	18·°22′
Toungoo	1890	Mr. Eccles	No. I	Bradley 1672 Polaris	30-46-35·934	37·235	1·301	36·584	—9·224	18·°56′
Letpataung	1891	Lt. Close	No. I	Bradley 1672 Polaris	168-13-12·544	14·157	1·613	13·350	—10·424	19·°34′
Taungpila	1891	Lt. Close	No. I	Piazzi XIII Bradley 402	351-51-46·890	47·860	0·970	47·375	—4·426	20·°42′
Mingun	1892	Lt. Burn	No. II	Groom : 2196 Polaris	174-23-57·431	*Nil.*	...	57·431	—8·414	22·°3′
Sheinmaga	1892	Lt. Close	No. I	Piazzi X Bradley 3058	354-23-25·015	22·033	2·982	23·524	—10·010	22·°17′
Male	1892	Lt. Close	No. I	Groom : 2007 Polaris	321-19-7·767	6·947	0·820	7·357	—7·862	23°3′
Ubyetaung	1894	Lt. Pilcher	No. II	δ Ursæ Minoris Groom : 750	181-29-39·166	42·193	3·027	40·679	—5·014	23·°41′
Thonbinzin	1894	Lt. Burn	No. I	Bradley 1672 „ 3147	277-46-12·763	12·774	0·011	12·769	—8·644	24·°14′
Seikpa	1895	Lt. Pilcher	No. II	Bradley 1399 „ 3147	258-32-25·712	23·831	1·881	24·772	—12·451	24·°36′

Statement of the outturn of work executed by No. 24 Party during season 1894-95.

INDUS DELTA COAST TRIANGULATION .

Description of details.	Secondary Triangulation.
Number of secondary stations newly fixed	32
Length of series in miles	77
Area of triangulation in square miles	300
Average triangular error in seconds	10·5
Linear error in feet per mile	0 57
„ „ „ „ „ (Intersected points)	0·25
Number of points fixed by intersection, but not visited	13
„ „ stations and points the heights of which have been determined .	45

Closing errors of the Indus Delta Coast Triangulation.

Values.	Pinjor Pir H. S. of Cutch Coast Series.			Pinjor Pir H. S.—Jamanvala T. S.		Remarks.
	Latitude.	Longitude.	Height.	Azimuth.	Side in feet.	
Calculated from the side South End Base—Clifton h.s. of the Great Indus series.	° ′ ″ 23-42-43·72	° ′ ″ 68-35-46·72	feet. 120	° ′ ″ 341-54-41·7	52697·6	″ Largest Δ′error 39·7. Smallest Δ′error 0·1. Mean Δ′error 10·5.
Accepted as correct from Synoptical Volume XXXIII G. T. Survey of India.	23-42-46·84	68-35-45·63	114	341-52-48·01	52691·9	
Closing errors .	″ −3·12	″ +1·09	feet. +6	′ ″ +1-53·69	feet. +5·7	

INDUS DELTA COAST TRIANGULATION.

Extract from the Narrative Report of MR. P. F. PRUNTY, *Extra Assistant Superintendent, No. 24 Party, on the* INDUS DELTA COAST TRIANGULATION, *Season 1894-95.*

The work under report comprised the extension of the triangulation along the coast to complete the fixing of the beacons that had been erected during the previous season between the Khobur creek and the coast of Cutch.

The detachment left Mussoorie at the latter end of October 1894 and reached Karachi, the base of operations, on the 1st November. All arrangements for boats, labourers, building material, supplies of every description, including water, had to be made at Karachi, and these were completed by the 10th November. The steam launch *Maud*, which was expected to reach me on the 8th November, was not forthcoming until the 18th and this unanticipated delay somewhat interfered with the starting of the work; but after the launch arrived considerable progress was made and by the end of December nearly all the country between Keti Bandar and the shores of Cutch had been reconnoitred and stations selected for the triangulation. The selection of stations was a work of considerable labour and anxiety, as owing to the revenue survey maps (my only guide) being quite out of date, the information they furnished was very misleading, and I was compelled to explore the country *de novo* in order to discover the situation of the coast line, and the geographical position of the waterways, and to take soundings in the latter as I went along, as they were only navigable at high tide. Besides this drawback, the physical difficulties of the country had to be overcome; the mangrove jungle that presented a formidable barrier to the triangulation of the previous season was hardly less so this year, and in addition to it the arms of the Indus, between Keti Bandar and the Mul mouth, a distance of 30 miles, were covered with tall grass, which grows to a height of about 12 feet; this grass is very stout and broad and resembles the branches of the date palm. The swampy nature of the ground into which the stand of the theodolite was always liable to sink; the strong breezes that prevail, preventing the use of an umbrella and thus depriving of

shelter both the instrument and observer; the haze and mirage which are always present, all combined to make accurate work impossible. After encountering very rough weather, and many difficulties through the failure of the water-supply, a junction with two of the principal stations of the Cutch Coast series was effected by the end of January 1895. Several secondary stations of this series were also visited inland, to fix the position of the beacons along the Cutch Coast.

On the 4th February the return journey was commenced. I reached Dehra Dun on the 3rd of March and reported my arrival to the Superintendent, Trigonometrical Survey.

The work in the Indus delta has been carried over a really remarkable tract of country—an almost impossible tract for a trigonometrical series, and save, for a few streams of fresh water between Keti Bandar and the Mul river, a stretch of about 25 miles, the series, for 150 miles, has been run through an inhospitable waste of sea water and pestilential mangrove swamp. It is obvious that in a country of this description special arrangements had to be made for supplies of every kind, and any break down in the commissariat would have been a serious matter It is a matter for congratulation that the work has been completed without very many mishaps. Last season one boat was swamped and two lives were lost: this season a boat was wrecked and a dozen lives might have been lost had I not been fortunate enough to come up to the sinking boat in time to rescue all on board, although there was a heavy sea on at the time.

The health of the detachment for the greater part of the season was very bad. It was a common thing to find half of the establishment prostrated with fever and diarrhœa and if I had not taken the precaution of serving out large doses of quinine every morning I should not have had a man fit for duty.

The only places met with along the coast between Karachi and Cutch were Keti Bandar and Narainsowar. Keti Bandar is situated on the east bank of the Turshian or Haidari branch of the Indus, about four miles from the coast. It is a seaport town of some importance and can boast of a municipal board, a school, a jail, and hospital and has a population of about 1,000 souls, mostly fishermen.

Provisions are scarce and wheat flour was selling at 6 seers for the rupee. The houses are built of mud and matting and the town is inclosed by a *bund* 8 feet high and 6 feet wide to keep out the inundation of the Indus. This precaution does not always succeed and a few years ago the Indus overflowed the bund and submerged the town, driving the inhabitants on to their house tops for shelter. The country around is marshy and the health of the town is in consequence very bad, and during the autumn months about 50 per cent. of the population are down with a very bad type of fever.

Narainsowar, in Cutch, where the season's work was brought to a close, is essentially a city of temples, all dedicated to the god Vishnu. It is situated on the eastern bank of the Khori creek and can only be approached at high tide. When the tide goes out boats are left high and dry, a very great inconvenience, which might easily be remedied by deepening the channel at a small outlay, and thus making the Bandar a comfortable anchorage for the numerous boats that visit the place.

I wish to record my obligations for the hearty co-operation of Captain Edward, the Port Officer, Karachi, and Mr. Judd, the Customs Officer of the Karachi Harbour. The latter officer rendered me considerable help in every possible way, and I attribute it to his influence with the boatmen along the coast that I was able to keep them from deserting as they frequently threatened to do.

One station and two beacons were washed away during the abnormal rise of the Indus last monsoon; one of the beacons was recovered by the Customs Officer at Keti Bandar. It has been re-erected on a new site at the mouth of the Khobur creek and refixed.

TIDAL AND LEVELLING OPERATIONS.

Extract from the Narrative Report of LIEUTENANT C. C. D. MORICE, R.E., *in charge No. 25 Party—Season 1894-95.*

At the beginning of the field season Colonel Hill completed the preliminary arrangements for the resumption of tidal observations at Madras in November 1894 and for the erection of the instruments at the new station of Diamond Island, Burma, in December. He also continued making the weekly inspections of No. 17 Party, which, as explained in the last Annual Report, he had undertaken in accordance with the Surveyor-General's instructions during the absence of Colonel Hobday on privilege leave; the last of these inspections was made on the 23rd October. During the field season Colonel Hill inspected the tidal observatories at Apollo Bandar and Prince's Dock, Bombay, in December and at Kidderpore (Calcutta) in January 1895 and also in that month made a special inspection of the new tidal observatory at Madras, for the purpose of satisfying himself that the observations at this station, resumed two months before his visit, were proceeding under satisfactory conditions. He had also intended to visit the stations Karachi and Bushire, but while the detachment under Surveyor Dhondu Vinayak, which was to accompany Colonel Hill to Bushire, was engaged in measurements and cleaning instruments at Maskat, a rebellion broke out there and the town was occupied by Bedawins. This resulted in the detachment being received into the British Residency, where Dhondu Vinayak

and the mechanic unfortunately fell ill and they ultimately arrived at Karachi unfit for further work. Under these circumstances Colonel Hill allowed Surveyor Dhondu Vinayak to remain at Karachi until he was sufficiently recovered to carry out the inspection there, and arranged that Mr. Belcham, with the other inspection party, should proceed to Bushire on completion of his work at the eastern stations: but Mr. Belcham arrived from Trincomalee, after his eastern tour, in a state of health which made it desirable to employ him in the Poona office before sending him on other work: it was then decided not to visit Bushire until next season, especially as the observatory had only been re-established in April 1894, and everything was known to be in perfect order. The arrangements for inspecting Minicoy tidal station were also interfered with by Dhondu Vinayak's illness, as Captain Channer, R.N., Superintendent, Imperial Light Service, had kindly undertaken to allow him a passage in his steamer at the end of March. Fortunately Minicoy observatory had been left in a condition fit to last till the close of the observations there next January, so this led to no inconvenience. In addition to the superintendence of the operations and ordinary office work, Colonel Hill completed and submitted for publication early in April the Chart of the Tidal and Levelling Operations showing approximate co-tidal lines, the preparation and scope of which have been adverted to in the last two Annual Reports. The chart, with the explanatory notes given upon it, is complete in itself, but it may be well to record briefly the foundations on which it is based. The outline diagram is simply an enlargement to a convenient scale of a portion of the Admiralty Chart No. 748B., "Indian Ocean, Northern Portion," applied to a rigorously delineated Mercator's Projection with which the graticule was found perfectly accordant. Portions of the chart extending beyond the northern limit of the Admiralty Chart were enlarged from the Index Chart to the Great Trigonometrical Survey to be found at the beginning of each of the departmental General Reports. The lines of levelling exhibited with the dates of their execution are from a very useful chart kept up to date as a record in this office, from the Index Chart mentioned above and from the pamphlets of spirit-levelled heights. All establishments, ranges, etc., for which authority is not obvious at first sight are taken from the Admiralty Tide-Tables, 1894, Taylor's and Findlay's Sailing Directories and the Admiralty Pilots. The conventional delineation of the co-tidal lines is necessitated by the present imperfect state of our knowledge regarding their exact figure. But the mass of information upon which the positions of the lines depend must render it, it is hoped, a substantial improvement on anything of the kind produced hitherto concerning the progress of the tidal wave in Indian waters. The sixty photo-zincographed copies of the chart are clear and easily read, though somewhat rough in execution. It is intended to have the chart ultimately engraved. The present issue will be distributed to persons to whom they are of interest and who assist the operations.

Colonel Hill also devoted much attention to the question of whether it would or would not be advantageous to introduce into these operations the new method of reducing tidal observations invented by Professor G. H. Darwin, which, as was stated in the last Annual Report, he is testing in conjunction with the inventor and Mr. E. Roberts of the Nautical Almanac Office.

Colonel Hill handed over charge of the party to me on the afternoon of the 5th April and proceeded on six months' special leave.

Tidal Operations.

During the survey year under review, tidal observations by means of self-registering tide-gauges were taken at thirteen stations, namely *Aden*, Maskat, Bushire, *Karachi*, *Apollo Bandar* (*Bombay*), Prince's Dock (Bombay), Minicoy, Trincomalee, *Madras*, *Kidderpore*, Diamond Island, *Rangoon* and *Port Blair*. The six tidal stations whose names are not italicised, are minor stations where observations, as a rule, are taken for five years only. Prince's Dock is included among them, as the continuance of its registrations beyond the limit of five years is not required by the general scheme of tidal operations, although the registrations are so useful to the officials of the docks that they seem likely to be continued indefinitely. The seven stations, whose names are italicised, are permanent stations where the minimum period of observations lasts for nineteen years, and where observations should continue to be taken until the work at all the stations is completed. In addition to the observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily at the following tidal stations, at all of which the tidal observatories have been closed with the object of comparing the actual heights and times of high and low-water with those predicted in the tide-tables: *viz.*:—Bhavnagar, Cochin, Tuticorin, Colombo, Chittagong, Akyab, Moulmein.

No tidal observatories were closed during the year.

The permanent observations at Madras were resumed in November 1894, and the minor station at Diamond Island (Burma), where great difficulties of design had been overcome, was established in December 1894.

It will be seen from the foregoing, combined with the particulars given in previous Annual Reports, that since the resumption of systematic tidal operations in 1877, observations have been taken at 34 tidal observatories, of which 21 have been closed on the completion of their registrations, and 13 are now in operation.

During the year 1895-96 tidal observations will be continued at the following stations, where they are now being taken, *viz.*:—Aden, Maskat, Bushire, Karachi, Apollo Bandar

and Prince's Dock (Bombay), Minicoy, Trincomalee, Madras, Kidderpore, Diamond Island, Rangoon and Port Blair. The observatories at Minicoy and Trincomalee will be closed in January and February 1896, or as soon afterwards as possible. The establishment of a minor tidal observatory at Perim has been sanctioned, supposing a suitable site can be found. Perim will be examined and arrangements made for the opening of the observations. If it can be conveniently arranged the observations will be started, but it is more probable that the preliminaries will be got through this year and the observatory started in 1896-97. The examination of localities and selection of suitable sites, if such exist, will also be undertaken this year at four places, namely, Mangalore, some suitable port on the east coast north of Bombay, and two places one on each side of the Isthmus of Kra between Burma and the Malay Peninsula. The lighthouse at Port Albert Victor, Bhávnagar, is not likely to be ready to receive the tidal instruments during 1895-96. It is possible also that Acheen and Bangkok may be visited and examined.

It is with great pleasure that I report the re-establishment of the very important permanent station of Madras, the only observatory in operation at present along the whole east coast of India. The tidal observations have been proceeding satisfactorily since last November at the new observatory forming the lower portion of the lighthouse at the seaward end of the recently-completed north pier of Madras harbour. As was stated in the last Annual Report, the Secretary to the Harbour Trust Board wrote on the 26th September 1894 that the engineer hoped to have the tide-gauge chamber ready early in October. It was actually ready early in November. Mr. Alfred Lee Pogson, A.M.I.C.E., the Engineer, Harbour Trust Board, Madras, whose valuable assistance is particularised further on, had every facility provided for the putting in position of the instruments, and with Mr. Belcham's help I got the observations fairly started by the end of the month.

It is an equal pleasure to record that the heavy expenditure incurred in the establishment of a tidal observatory at Diamond Island (Burma) has resulted in the observations being started. The preliminary tests to which the system was subjected to ascertain whether the communication between the float-cylinder and the sea is to be depended upon, were fully described in the last Report. They were satisfactorily continued till December 1894, when Mr. Belcham arrived and succeeded, with the co-operation of the Superintending Engineer at Rangoon and of the Executive Engineer at Bassein, on the latter of whom the actual preparation of the well, cylinders, communication, etc., had devolved, in starting the observations by the 30th December, so that the analysis can be commenced, as was desired, from the 1st January 1895.

It was reported last year that a new method of reducing tidal observations, invented by Professor G. H. Darwin and very greatly diminishing the amount of arithmetical calculation involved, is being tested by Colonel Hill in conjunction with the inventor and Mr. E. Roberts of the Nautical Almanac Office: the progress of the testing was described in the appendix to the General Report for that year (p. lv.). As there explained it was intended to compare Tide-Tables for Aden 1885, obtained by the new method from the observations taken in 1883-84, with the actuals for 1885. The comparison was made and the tables were found satisfactory as to height, but about 20 minutes too early on the average. But the tides of the year 1883-84, as Professor Darwin pointed out, *were* somewhat earlier than those of preceding and subsequent years. So, at Professor Darwin's suggestion, the constants obtained by the new method were utilised to produce by means of the tide-predictor the curve for the very same period during which the tidal observations had been carried on. The same process was undertaken with the constants derived by the old method from the observations for the same period. A perfectly just comparison of the two methods was thus devised, to see which of the two curves thus produced accorded with actuality more precisely. At first Professor Darwin was inclined to think there was not much to choose between them: but he tabulated only a small number of ordinates and had to compare them with the official Tide-Tables for 1883 for want of the actual values. On close examination by the usual percentage and other methods, the new method appears to be distinctly less exact than the old, though still very accurate. But a strong impression was left on my mind that before making such a sweeping change as introducing the new method into this office, it should be tested not at one port for six months, but at several ports for several years each: for the variations of the accuracy of these predictions from month to month were remarkable. Further, I am of opinion that, now the tidal and levelling operations are drawing to a close it would be a great mistake to disorganise the party by introducing the new method, which would also throw the work in arrears and render it impossible to carry out the necessary duties of inspection, etc., during the time the whole system of working was being started on new lines. Colonel Hill's final report on the question will be submitted in due course: but I think it well to quote the last two paragraphs of his letter dated the 19th February 1895 to Professor Darwin. "Of the ten native computers now employed in my office on tidal calculations, seven (receiving each a monthly salary averaging ₹17 or about 18 shillings) are confined to simple addition, while the three best (receiving each about ₹30 or 32 shillings per mensem) are employed on the more difficult portions of the calculation. A good and very economical outturn is thus obtained: and the checks of various kinds introduced into the tidal calculations enable a single European assistant to superintend effectually this portion of the office work. The abridged method could only be taught to the best (and consequently best paid) native computers: and to work it properly (allowing for the usual leave, casualties and special work) about seven of them would be required. Quite a year would be lost in training them,

and permanently increased European supervision might be found necessary: for the abridged method admits of far fewer checks on mistakes or fabrications than the old method. The great saving of time and labour (so important in England) to be eventually effected by using the abridged method would not, I fear, be considered by the Indian authorities equivalent to the cost of introducing and working the method in my office.

"If the foregoing objections could be removed, one grand objection to using your abridged method in my office would remain: and I regret that, attracted by the beauty of the method, I did not give sufficient weight at first to what I regard as a most important consideration. The Indian tidal operations are drawing to a close. Their records supply a wonderfully complete and intelligible series of observations, calculations and statistics, the study of which may possibly prove of great value to future investigators. Would it not be a serious mistake to break the continuity of the calculations and records (rendering the later portions non-comparable with the main portions), especially in the case of the permanent tidal stations, at which the observations have to be extended over a period of at least nineteen years?"

A practical difficulty has occurred in the application of the principle laid down in, or shortly prior to, 1885 by Professor Darwin, Major (now Colonel) Baird, R.E., and Captain Wharton, R.N., that the scientific datum called "Indian Spring Low-Water Mark" should be adopted for charts of Indian waters. The values of this datum at several ports obtained from the tidal computations had been supplied to the Marine Survey of India Department for the Admiralty Charts. But in all these cases there had been observations extending over periods not less than one year. At ports where a year's observations are not available it is impossible to determine the value of "Indian Spring Low-Water Mark" for it depends on the mean sea level, which, as will be well seen from the next paragraph, cannot be certainly determined from observations extending over short periods. So that it is far better in such cases to adhere to any real datum such as "the lowest tide observed during the survey" than to the misleading and possibly dangerous value arrived at by attempting to compute a rough value of "Indian Spring Low-Water Mark." In order to finally satisfy myself upon this point, I decided, after discussion with the Officer in charge, Marine Survey of India Department, to endeavour to find "Indian Spring Low-Water Mark" at Kankesanturai, where he had two months' good tidal observations (taken by means of a tide-pole) available. We considered the best analysis for the purpose to be Professor Darwin's method for reducing tidal observations extending over short periods (given in the Admiralty Manual of Scientific Enquiry, 1886). I worked out the whole calculation, and Mr. Connor worked it out independently, with identical results, and we found the datum obtained to be higher than some of the low-tides observed in the short period analysed, and therefore clearly dangerous. However "Indian Spring Low-Water Mark" has now been compared with the previously existing chart-sounding datum-lines such as the level of low-water ordinary spring tides at a number of places in Indian waters, and the difference is not large or important (*vide* page XIV, Appendix X, General Report, 1889-90). The Admiralty Tide-Tables for the British and Irish ports, 1894, contain in the preface the following statement: "Since at places where there is a large diurnal inequality, the water often falls considerably below the true mean of the low water levels at spring tides, it has been decided that the datum generally in use for charts, *viz.*, the level of low-water ordinary spring tides, shall be considered to be equivalent in the harmonic notation to the sum of the semi-ranges of the principal lunar (M_2) principal solar (S^2), semi-diurnal tides, and of the luni-solar diurnal (K_1) and the lunar-diurnal (O_1) tides below the mean sea-level: that is to say

$$A_0 - \{ H \text{ of } M_2 + H \text{ of } S_2 + H \text{ of } K_1 + H \text{ of } O_1 \}$$

above the zero of the tide-gauge. This is the formula defining "Indian Spring Low-Water Mark," and it would be inferred that the value of it would often be considerably lower than, and consequently safer than that of "the mean level of the low water of ordinary springs." But, as just stated, it has been found in Indian waters that there is little, if any, advantage obtained as regards safety by its use.

So it appears to matter little that this scientific datum cannot be generally introduced.

It was mentioned in the last Report that the question of the variation of mean sea-level from time to time during the year at the tidal stations was under consideration. One object of this was to ascertain whether one season is better than another for tidal observations, so that a season might be chosen which would give results nearly as good as those of a whole year. A considerable amount of labour has been undertaken and the precise values of the monthly mean sea-levels at thirty-four tidal stations have been computed and tabulated for the full period possible in each case up to the end of 1893. These tables are too voluminous to be printed with this report, but those for Aden and Kidderpore are given as specimens, and the whole are preserved for reference in this office. They may be considered as a further development of the table of variations in yearly mean sea levels given at page lii of the Appendix to the last General Report.

Curves plotted direct from the tables, to exhibit the variations graphically, bring out the fact that the mean-sea-level for any month (however precisely determined) may be considerably above or below the mean sea-level for a whole or several years and that in different years the mean sea-level for the same month is liable to vary considerably. This confirms the truth already made evident on more than one occasion by these operations, that no value of mean sea-level reliable for such work as spirit-levelling of precision or

for calculating precise scientific datum-lines (such as Indian Spring Low-Water Mark) can be obtained by tidal observations extending over one lunation only. The coincidences which have occasionally occurred have led to some misconception on this point. For instance, the mean sea-level at Karachi taken in 1862 during one lunation (upon which the tables of heights in Sind, the Punjab, etc., up to May 1862 depend) agreed very fortunately within 0·007 foot with that determined by our subsequent tidal operations from twenty years' observations: on the other hand, the mean sea-level at Madras, determined by Major de Havilland from May to October in 1821 is about one foot higher than that determined by our operations from the years 1880-90.

The tables and curves appear to corroborate the quantitative lunation of the long period tides Sa (annual) and Ssa (semi-annual) effected by the harmonic analysis at the ports in question. Thus all down the west coast of India the effect of these tides is seen by the tables and also found from the harmonic analysis (*vide* tables of tidal constants (H's) in the Appendices to the General Reports) to be variations of the mean sea-level ranging within about a foot and a half, while at Kidderpore, Chittagong, Rangoon and Moulmein (the four principal riverain stations) the tables and the constants both indicate variations of several feet. The whole investigation illustrates in a very interesting way certain statements on page 26 of the British Association Report, 1883, of a Committee for the harmonic analysis of tidal observations drawn up by Professor G. H. Darwin. As to meteorological tides it is there stated that though the semi-annual and annual tides are probably quite insensible as arising from astronomical causes, yet they have been found of sufficient importance to be included in the tide predictor, and they are of enormous importance in some rivers.

The question of the reliance to be placed upon the meteorological observations taken at the tidal stations was summed up by Colonel Hill last year—(page xl, Appendix to General Report, 1893-94). It seems possible to arrive at an estimate of the value of the observations even from the commencement of the work (since many of the instruments used at that time are still in use) by a system of comparison with standard instruments kept at Poona, and of test comparisons of two or more thermometers kept in each observatory. I have been favoured by Mr. Eliot, the Meteorological Reporter to the Government of India, with a letter explaining the results of his great experience of such comparison work. I hope that this will lead to a satisfactory disposal of the question.

I shall now describe briefly the working of each tidal observatory, commencing with Aden and following the order of the stations round the coasts to Burma, including in this survey those stations, where, in lieu of automatic tidal observations, personal observations to a graduated staff are taken daily, in order to furnish comparisons between the actual and the predicted heights and times of high and low-water.

Aden.—The observations at this station have been satisfactory on the whole: the self-registering tide-gauge worked well: there were only two trifling interruptions in the registrations, each lasting about six hours and due to the failure of the pencil to mark the curve.

Of the auxiliary instruments the aneroid barometer has worked without interruption, and has shown diurnal variation: its readings, however, require a minute correction discovered to be necessary during the inspection.

The anemometer also worked without interruption except on a single occasion when the clock stopped and was not restarted for 24 hours; on two occasions the clerk forgot to release the spirals.

The mercurial barometer and the rain gauge were in good order.

The tidal observatory was inspected by Surveyor Dhondu Vinayak in October. He found it in excellent order. All the instruments were cleaned and left in adjustment. The float-cylinder was noticed to be slightly out of the vertical, causing the float to come in contact with the interior of the cylinder at times The gauge was shifted bodily about 1½ inches further from the cylinder and this position was found to make up for the slight defect in the setting of the cylinder, in position, and to give the float plenty of room. The observations had not been affected. The pencil-holder of this gauge is too long and the clerk had only prevented its bearing on the drum by the use of a paper washer: a brass one was provided. The aneroid and mercurial barometers were found slightly discordant: this brought to notice the fact that the clerk had for a long time neglected to cut his aneroid diagrams so as to enable him to adjust the line of reference correctly: a minute correction ought therefore to be applied to the aneroid diagrams from 11th January 1892 to 22nd October 1894: the same remark applies to those from 2nd June 1890 to 30th November 1890: but as, if utilised, the curves would probably be combined with precise readings of the mercurial barometer, the actual application of the correction is not likely to be necessary.

I regret that Colonel Hill's recommendation that the clerk should be provided with an assistant has not been complied with: the clerk appears to have conducted his observatory work satisfactorily: but in spite of correspondence on the subject, the Aden records fail to reach Poona as promptly and regularly as they should.

Maskat.—At this station the observations have been highly satisfactory; the tide-gauge record was interrupted on only three occasions; the driving clock got out of order on the 19th January, but it was put right and restarted by the local watch-maker within four hours: owing to the occupation of Maskat by Bedawins, alluded to above, the observatory could not be regularly attended by the clerk from the 15th February to the 10th

March, and the clock ran down at 7·17 P.M. on the 21st February; it was restarted at 8·50 A.M. on the 24th of the some month: the last interruption was during the absence of the clerk on leave; the assistant clerk fell ill and the clock ran down at 7·45 A.M. on the 16th April, and was not restarted till 9 A.M. on the 19th April. Interpolation by means of the predictions was utilised to replace the missing curves in the two latter instances. The clock had a gaining rate for some months, and the errors very often exceeded three minutes: but they were duly corrected on the diagrams.

The aneroid barometer has again worked without interruption; but its record is not quite accurate, as the instrument is still insufficiently sensitive.

The anemometer clock stopped on the 10th and the 11th December and on the 22nd and 23rd January: it was restarted within a few hours on each occasion: no record was obtained from the 14th April (8 A.M.) to the 19th April (8 A.M.) owing to the illness of the assistant clerk mentioned above. The mercurial barometer, the sun-dial, and the rain-gauge remained in good order.

There was heavy weather in November and January, but no damage resulted from it: in July the clerk reported that the timber of the dam needed repairs, and steps were taken to ensure their being properly executed.

The tidal observatory was inspected by Surveyor Dhondu Vinayek in February. As mentioned above, Maskat was occupied by Bedawins during the time the inspection was proceeding. Dhondu Vinayek and his detachment were obliged to take refuge in the British Residency, where he and the mechanic fell ill. The inspection was properly completed in spite of the difficulties and discomforts entailed by the state of affairs. The structure of the observatory was found in good order. All the instruments were cleaned and left working well, except that the aneroid barometer continued insufficiently sensitive. In spite of the precautions taken at the previous inspection, a certain amount of spray had found its way into the observatory, and some of the mechanism of the clock of the tide-gauge had rusted in consequence: this may account for the fact that the rate of the clock had altered a good deal. A quantity of gravel and stones, which had accumulated in the bottom of the indentation over which the observatory is built, was cleared away: the dam, cylinder and iron-work were all in good order.

Both clerk and assistant clerk have performed their duties very satisfactorily.

Meteorological records have been forwarded periodically by the clerk to the Meteorological Reporter to the Government of India, whose meteorological instruments, as well as all the other instruments, have been kept clean by the clerk and attended to punctually according to instructions. The clerk has been awarded R60 for special storm observations.

Major J. Hayes Sadler, Her Britannic Majesty's Consul and Political Agent at Maskat, has the kindness to visit the observatory occasionally: he extended assistance of every kind to the inspecting party during the disturbances described above, and gave orders as to their visiting the observatory, which was outside the area protected by the Residency, from day to day. His co-operation has been most valuable.

Special thanks are also due to Surgeon-Colonel A. S. G. Jayakar, Civil Surgeon, Maskat, who has previously rendered his assistance when Acting Political Agent, and who prescribed for and assisted Surveyor Dhondu Vinayak and the mechanic when they fell ill.

Bushire.—At this station the observations have been proceeding most satisfactorily. The self-registering tide-gauge worked particularly well; the driving clock stopped twice, on the 12th November, when it was restarted after about half an hour, and on the 7th January, when it was restarted after five hours. The pencil failed to mark the curve on the 4th and 5th December for three and nine hours respectively. Tidal diagram No. 74 for the week 3rd to 10th September 1894 was not received in this office, and all attempts to trace it have failed: unfortunately, the fact of its being missing, though duly recorded, was not brought to the notice of Mr. Connor and myself until some months had elapsed, and the difficulty of tracing had become much greater: steps were taken to prevent a recurrence of such mishaps, of which there has been no previous instance within my recollection: the loss of this particular diagram is not of very great importance, as the curve plotted from the hourly readings entered on the daily reports as a precaution against such accidents, is as good as the original curve for all practical purposes. It has been placed with the self-registering tide-gauge diagrams in place of the missing sheet. The oscillations of the surface of the water at Bushire are, as might be expected from the shape of this portion of the Persian Gulf, decidedly irregular and much influenced by the wind. Those for October, November and December 1894 are particularly interesting, presenting changes of level of as much as 2 feet occurring in the most unexpected manner, sometimes apparently explained by variations of wind, sometimes quite incapable of explanation by reference to the meteorological records.

Both the aneroid barometer and the anemometer have uninterrupted records: but owing to the illness of the tidal observatory clerk the anemometer diagram put on at noon of the 19th October was not taken off till noon of the 22nd of that month. A tremor was noticed in some of the anemometer diagrams, due probably to a loose adjusting pin.

As already explained, it was not convenient to inspect this observatory during the year's inspectional touring, and as it was known to be in excellent order it was left to await inspection in the coming cold weather.

Mr. Newcome Wilson, a senior Telegraph clerk, relieved Mr. Twells as tidal observatory clerk on the 31st January, and has performed his duties very satisfactorily.

I am much obliged to Mr. B. McMullen, Assistant Superintendent, Telegraph Department, who kindly continues the supervision which Mr. T. Y. Johnstone, Superintendent of Telegraphs, exercised over the observatory until he left Bushire.

Karachi.—At this station the self-registering tide-gauge worked very satisfactorily throughout the year. The only irregularities were the following:—

The driving clock stopped on the 29th December, but was restarted within two hours. The communication became imperfect on the 10th March, 25th June and 6th August for 12, 2½ and 2½ hours respectively. The imperfections in the tidal curves so occasioned were insignificant: and in all cases the curves were readily completed by interpolation. A new graduated staff was set up on the 12th January in place of the old one, which was removed on that day.

The aneroid barometer got out of order in the middle of May, and was returned to Poona in November for repairs. Another instrument, No. 42, was sent from Poona and set up by Surveyor Dhondu Vinayek on the 5th February. It has been working since then without interruption.

The anemometer record was most satisfactory. No failure of any kind occurred during the year.

The observatory was inspected by Surveyor Dhondu Vinayek in March. He found everything very neat and clean and well looked after. The usual measurements to detect the accumulation of silt in and around the cylinder were made periodically throughout the year. The float-band was found partially cut near the middle of its length. A piece of new band was placed over the weakened part.

The tidal observatory clerk, Jhamat Mal, performs his duties very satisfactorily.

Mr. Morris, the Port Engineer, has the kindness to generally superintend the work, and, under his direction, Mr. Dharam Sing immediately supervises the observatory. For many years Mr. Dharam Sing has been of great assistance, visiting the observatory frequently, taking measurements for determination of zero when required and providing for all necessary cleaning and repairs.

Porbandar.—With regard to the correspondence between Colonel Hill and the Administrator, summarised in last year's Report, sanction has been received for the selection of a tidal station north of Bombay as a part of the general scheme of tidal observations; it must now be determined whether Porbandar is suitable for selection as that station.

Bhávnagar.—I am much obliged to Mr. Proctor Sims, the State Councillor and Engineer, for his continued interest in the operations. Since the removal of the tide-gauge, tidal readings to the graduated staff (whose zero agrees with the zero of the tide-gauge, and not, as is usual, with the datum of the tide-tables) are being taken daily under the direction of Captain Godrich, to whom I am much obliged for supervising them and sending them to this office monthly, compared with the corresponding predictions given in the tide-tables. The comparisons show that the predictions are highly satisfactory. It must be borne in mind when considering such comparisons, that a few minutes' error in local time is quite possible, and that, although heights, except in rough weather, can be accurately observed, the times of high and low-water cannot be determined with great precision by observations to a tide-pole. When the time of high and low-water is measured by two independent trained observers from the tidal curve traced by a self-registering tide-gauge, their permissible difference is 10 minutes: and at least as great an error may reasonably be allowed when readings are taken from so rough an appliance as a tide-pole.

Apollo Bandar, Bombay.—The tidal registrations at this station have been most satisfactory and have proceeded without a break throughout the year under report: in fact the tide gauge has worked without a single failure since November 1886, an admirable record. The graduated staff was repainted on the 27th and 28th May. The observatory well was cleaned out on the 13th and 14th December: about four cartloads of mud were then removed. Colonel Hill inspected the observatory in December and found everything kept in very good order by the clerk, J. Fernandez: at the close of the inspection the tide-gauge was left clean and in perfect adjustment. The gauge was numbered No. 2. The counterpoise chain was found hanging by one end: the hook at the bottom of the float had corroded and the float end of the chain had broken loose: this trifling defect was remedied.

Auxiliary instruments are not employed at either of the Bombay tidal observatories, as the necessary meteorological observations are taken at the Colaba Observatory.

Prince's Dock, Bombay.—The self-registering tide-gauge with short upright drums, of the pattern in use at this station only, has worked very satisfactorily, though the numerous short interruptions in its record continued to prove it inferior to the ordinary instrument of Newman's pattern, which is capable, as shown in the preceding paragraph, of working for years without a single failure. The driving clock stopped once in January and nine times in September; on each occasion it was restarted within a few hours. On the 24th September the mechanic of the Party, who had been sent down from Poona for the purpose, examined the clock and found that the hour-hand wheel pinion had broken. A new wheel was inserted and the clock restarted the following day. On fifteen occasions the upper edge of the diagram got twisted and slightly torn, but in no case was the curve affected by this. The pencil twice failed to mark, for a few hours on each occasion. The clerk was on sick leave for three months, from July to October 1894. On the 16th October 1894 he noticed that the man who acted for him had misplaced the diagram on the 23rd July 1894, by setting the diagram to the 9 P.M. line of the drum: this was immediately rectified: it

did not affect the correctness of the diagram as the clerk had marked the time-lines on it correctly and without regard to the time-lines marked on the drum. The observatory was inspected by Colonel Hill in December; he was assisted, as usual, by Surveyor Dhondu Vinayek. The float-band was found twisted twice a few feet above the float. This probably was caused by the clerk repairing the band in February. The working zero of the gauge was very slightly altered by this defect. The band was straightened and the gauge was left in perfect order and adjustment. It is intended to introduce a screw arrangement for adjusting the zero of the gauge with greater facility and precision. The clerk has been performing his duties satisfactorily.

I am indebted to Mr. Squire, the Engineer to the Port Trust, who exercises a general control over the working of both the Bombay tidal observatories.

Cochin.—I am much obliged to Mr. H. Wodehouse, the Port Officer at this station, for having furnished to this office regularly the monthly tabulated comparisons between the values given in the tide tables and the times and heights of high and low-water obtained daily from readings to a graduated staff or tide-pole in the manner described in the paragraph on Bhávnagar. The height predictions contained in the tide-tables for 1894 agree very closely with the actuals: but assuming the correctness of the Port Officer's time, the time predictions were on the average about 15 minutes too early. During 1895 the height comparisons have remained satisfactory, but the time comparisons up to date show the predictions to be still about 15 minutes too early The remarks on this class of test made in the paragraph on Bhávnagar apply particularly to this station also.

Minicoy.—The tidal observations at this remote island station have been again very satisfactory. Owing to the isolation of Minicoy (which is only visited at regular intervals by the steamer carrying the Superintendent, Imperial Light Service, from Ceylon) it is not possible on each 1st October to report on what occurs there during the exact period included in the Survey year, and the following remarks will deal with observations from the 4th September 1894 to the 29th August 1895, the date of the last daily report received in this office. The tide-gauge clock worked without a single stoppage. The graduated staff was removed on the 9th March to be repainted and a new one, which had been stored for the purpose, was set in its place. Heavy weather was experienced in the monsoon, and in June a quantity of sand accumulated opposite the observatory, raising the bed of the lagoon there about 2 feet. The communication holes became partly blocked and retardation was noticed on the 27th June. The clerk was very diligent in having the sand repeatedly removed from around the cylinder. On the 6th July, when the lowest tides occurred, two additional holes about $\frac{5}{16}$ inch in diameter were bored in the cylinder to improve the communication—one about 9 inches and the other about 1 foot above the existing communication holes. No retardation was noticed after this. The imperfections in the curves due to retardation will be remedied by means of the predictions. The clerk took sun-dial measurements and zero measurements and cleaned out the cylinder and cleared the sand away from outside it from time to time. No alteration took place in the zero of the gauge according to these zero measurements.

Of the auxiliary instruments, the aneroid has a very satisfactory record: its driving clock stopped on the 3rd, 4th and 5th June, but was restarted in each case within a few hours. The anemometer registrations were interrupted only on one occasion, on the 10th June, when the cord of the driving weight broke: it was renewed next day.

The mercurial barometer, sun-dial and rain-gauge remained in good order throughout.

The clerk, J. F. Francis, performed his duties very satisfactorily; he deserves special commendation for his diligence in keeping the communication open during the time the silting-up was noticed and for keeping all the observatory clocks to correct time.

The special daily observations taken for the Meteorological Reporter to the Government of India have been continued satisfactorily and transmitted to Calcutta as usual.

As was explained above no inspection of Minicoy was made during the year, but the observatory had been put in a condition to last till the close of the observations (January 1896) at the last inspection.

Special thanks are again due to Commander A. Channer, R.N., for his kindness in carrying our men and their supplies between the islands of Minicoy and Ceylon, thereby much facilitating operations: to the Collector of Malabar we are also indebted for his co-operation ever since the commencement of the tidal operations at Minicoy.

Tuticorin.—Captain Baker, the Port Officer at this station, kindly continues to send me every month the daily times and heights of high and low-water, obtained from readings taken during day light to a graduated staff. Some inconvenience has been caused by the observer entering the exact predicted values as having been also the actual values on days when he noticed no large difference between them. A letter was addressed to Captain Baker on the necessity of the clerk recording the actual values as observed by him, to ensure a trustworthy record. The results of the comparisons between the observed values and the corresponding predictions in the tide-tables continue to be most satisfactory.

Colombo.—The engineer in charge of the harbour works at this station has the goodness to furnish observed tidal values for comparison with the values contained in the tide-tables. The comparisons have been made for the year 1894, and in the case of both times and heights are very satisfactory.

Galle.—Owing to the smallness of the range, and the roughness of the sea at this station, daily verificatory observations are not taken: but Captain Blyth, the Master

Attendant, undertook, as mentioned in the Annual Report for 1892-93, to test the tide-tables daily, and report any marked difference occurring between actual and predicted tides. As yet no report has been received from him.

Trincomalee.—The tidal observations at this station have continued to be satisfactory: the tide-gauge clock stopped on five occasions but was always restarted within a few hours: the pencil broke on the 20th June, causing an interruption of three hours only. From the 4th to the 8th July the pencil stuck once each day and was released on each occasion within two hours. The tidal curve was noticed to be very peculiar, as if the gauge were working stiffly. This was communicated to Mr. Forsey, and he had the gauge looked to by the foreman of the naval dockyard. The curve improved after his visit. Special attention had been directed by Mr. Belcham to the sensitiveness of the gauge during the inspection in February and it was found quite satisfactory. In October 1894, there were some abnormal curves; between the 5th and the 12th of the month the incidence of the tides was so accelerated that one more high and one more low-water were registered during those eight days than had been predicted: there were nothing defective in the working of the gauge so far as can be judged by close examination: neither was there anything in the state of the weather to account for so peculiar a circumstance: by the 12th the tides were again in harmony with the predictions; the tides at Trincomalee have a very small range and the difference between high and low water on the days in question was very small, not exceeding about one foot: this renders the occurrence somewhat less surprising; but no satisfactory explanation of it has yet been arrived at. The differences between the times and heights, actual and predicted, for these few days have not been admitted into the calculations for estimating the average accuracy of the tide-tables for 1894 at this station, as the former are quite different from anything recorded previously or subsequently.

Of the auxiliary instruments, the aneroid barometer worked remarkably well and without a single failure. The anemometer continued working irregularly, showing sometimes only the direction and sometimes only the velocity of the wind till the inspection, when Mr. Belcham removed it on the 5th March and set up another instrument, No. 42, which worked properly for the remainder of the year, except that its driving clock needed looking to on two occasions. The mercurial barometer, sun-dial, and rain-gauge remained in good order throughout the year.

At the inspection in March Mr. Belcham found the instruments much in need of cleaning: the coal-dust settles everywhere in spite of all possible precautions. He found that the clerk had been ill between the 17th and 28th of October and had been assisted by a friend in his observatory work: the differences between the readings of the aneroid and the mercurial barometers for that period are excessive, and amounted to as much as 0·8-inch. These instruments were found quite accordant, but somewhat large differences were noticed between them at times after they had been cleaned. The anemometer, No. 42, set up in place of the defective instrument, has no connecting screw to facilitate setting the diagram to correct time. The graduated staff was found covered with shell-fish, and was removed on the 9th March. A new one was set up the same day. The clerk has performed his duties satisfactorily.

I am indebted to Mr. J. Forsey, the Naval Storekeeper, for his continued kindness in exercising a supervision over the tidal observations.

Madras.—The new observatory at this station occupies the lower portion of the light-house at the seaward end of the north pier of the harbour. The extremity of the pier consists of an immense cylindrical block of concrete, which was formed by floating an iron caisson into position and sinking it by admitting the water into it through large sluices. The caisson was then filled with concrete. The design provided for a central circular well 6 feet in diameter and about 25 feet deep reaching from the top of the caisson (11 feet above the highest tides) to about 8 feet below the lowest tides and connected with deep water by a shaft, one foot square in section, passing straight and slightly downwards from nearly the bottom of the well to the outside. The outer end of the shaft is 27½ feet above the bottom of the caisson, which rests on a carefully-prepared concrete surface extending 20 feet outwards all-round: a rubble slope descends gently to the sandy bottom of the harbour. The tide-gauge float works in the well and the light-house is built immediately over the well, so that the observatory occupies its ground-floor room.

I included a very detailed description of the observatory and everything connected with it in my inspection report for record in this office, drawn up at the time of restarting the observations (November 1894). Plans, working, drawings, etc., were given and a copy was entered in the observatory inspection book.

A sluice is utilized to control the admission of the water through the shaft. It is a powerful screw sluice which was fortunately available after being utilized to sink the caisson: another precisely similar to it is kept ready to replace it should it get out of order. A vertical shaft and handle enable the screw sluice to be adjusted from the tide-gauge chamber. The sluice is working with an aperture of ⅝-inch obtained by turning the handle two and a half turns (each 360°) from dead shut. The sluice is worked occasionally to keep it from jamming. Experiments with a head of water obtained by shutting the sluice at low-water proved that no retardation can exist with the present aperture.

As contemplated at the time the observatory was designed, the iron cylinder, hitherto invariably utilized for the float to work in at all the tidal observatories was not provided

at Madras. The nicety with which the sluice regulates the communication with the sea admits of this. Sources of error, such as imperfect representation of the sea-level, and inconveniences, such as renewals of corroded cylinders, etc., are avoided by this plan. No tendency of the float to wander from its position vertically beneath the stud-wheel has been observed.

The tide-gauge chamber is well suited to its purpose, but it is of the very smallest dimensions (12 feet diameter, circular, and 8 feet high) which will accommodate the pattern of tide-gauge in use.

As a means of roughly checking the agreement of the water levels in the well and in the deep water outside, a permanent iron enamel-graduated tide-staff is used. This was set up by the Engineer, Harbour Trust Board, for his own observations, and is situated about 500 yards from the observatory at the place where the pier bends southwards.

The self-registering tide-gauge is the one that was used at Akyab, known as No. 27. It is working on half the natural scale. It has worked most satisfactorily up to the present: the only interruption being one of twelve hours when the driving-weight cord broke. After setting up the gauge the sensitiveness and balance of the instrument were tested; it was found that after disturbing the equilibrium by turning the stud-wheel either way the float did not always return to the same position though the sluice was closed. This was found to be due to the friction in the instrument, which was such that the water could rise or fall $\frac{3}{4}$-inch without overcoming it. It was not found possible to reduce the friction in the machine, so it was suggested that a larger and more powerful float should be employed, powerful enough to instantly overcome the friction when the water-level changed. The Engineer kindly volunteered to have one made: while waiting for the new float every effort was made to get the instrument to work satisfactorily with the old float, but without success. The new float measures 2 feet in diameter and is therefore four times as powerful as the old one: it is about 7 inches high at its centre and 2 inches at its circumference. Its weight is 15lb, as compared with $8\frac{1}{2}$lb, the weight of the original one; but this difference does not add to the strain on the band, etc., as the extra weight is supported by the water. It has ball-bearings above water for all motions of a through spindle by which it is connected with the band: this spindle does not turn when the float turns.

At first a copper counterpoise chain of the usual pattern was employed, but it was found to twist itself into a tangle when the instrument was left working; this, of course, upset the balance of the gauge, it was proved that the absence of the chain could not sensibly affect the accuracy of the gauge: so it was discarded.

A gun fired from the Fort at noon is observed daily for keeping the clock to correct time.

The bed-plate of the tide-gauge was connected by double-levelling with four bench-marks of reference, and these were connected with the principal bench-marks in Madras.

The usual set of auxiliary instruments are not employed at this station, as the necessary meteorological observations are taken at the Madras observatory. As, however, an anemometer of Adie's pattern, the property of the Engineer, was at work on the roof of his office, and he did not require its diagrams for his own use, he was good enough to allow the clerk to attend to the instrument daily and send the diagrams to this office until the 27th April, when the record was discontinued.

A mercurial barometer, No. 1681, by Casella, the property of the Survey of India Department, was set up in the observatory at Colonel Hill's request, by the Engineer, and its readings have been systematically recorded since the 22nd May. The instrument which I took down to Madras with me in the preceding November unfortunately leaked through a permanent joint in transit and had to be taken back to Poona.

The observatory, together with the instruments, is in charge of the Engineer, Harbour Trust Board, who supervises the operations and forwards the clerk's reports, etc.

The clerk, Vythinath Iyer, who was formerly employed at Tuticorin (1888 to 1893) and before that at Negapatam, has performed his duties very satisfactorily.

Colonel Hill inspected the observatory, to satisfy himself that the observations had been restarted in a satisfactory manner, in the month of January: he found everything thoroughly satisfactory.

To Mr. Alfred Lee Pogson, A.M.I.C.E., etc., Engineer, Harbour Trust Board, cordial thanks are due for the manner in which he responded to the invitation to take up the question of the new tidal observatory, for putting the design into execution, for assistance of various kinds at the starting of the observations, and for his supervision of the observatory. I am particularly indebted to him for his unfailing readiness to assist me in the work when I was at Madras. With the resources at his disposal, skilled labour, workshops, etc., it was only necessary to indicate what was required and he had the work executed in the best possible manner.

Cocanada.—As mentioned two years ago tidal comparisons by means of a tide-pole have been discontinued at this station, which is the more to be regretted, as large discrepancies between the actual and predicted heights in certain cases were indicated by the observations. I can now only expect to receive, through the kindness of the Port Officer, particulars of such tidal discrepancies as are sufficiently remarkable to attract his attention. No such particulars have been sent this year.

Kidderpore.—At this station the tide-gauge worked very well throughout the year: in January the clock stopped on four occasions, but on each it was restarted within four hours.

Of the auxiliary instruments, the aneroid has a continuous record except for one considerable interruption in November. The diagrams were not marked from the 31st October to the 15th November and the clerk neglected to report the failure of the instrument. On the 8th of November the clock stopped several times: it was removed for repairs on the 14th of that month: it was restarted at 4 P.M. of the following day.

The anemometer record continued satisfactory and without interruption through the entire year. The mercurial barometer and rain-gauge remained in good order.

Colonel Hill inspected the observatory in January: he found the clerk absent without leave till 11-30 A.M., when he should have attended at the observatory at 7 A.M. The man requires vigilant supervision. There was an alteration of 0·105 foot in the working zero of the tide gauge from its value at the previous inspection: the clerk failed to account for it: some alteration of the adjustment of the pencil must have taken place, as the band and float were found to have undergone no change.

The aneroid barometer was found to be marking its diagrams very faintly. The protecting cup of the anemometer, which should have been emptied, was found half-full of rain-water, and the instrument was very dirty.

The observatory house is in a dilapidated and worn-out condition. Colonel Hill addressed the Port Commissioners with a view to their providing a proper observatory to enable the observations, which are permanent, to be satisfactorily continued. After some correspondence he was informed that the present structure was considered to be still good enough to serve its purpose.

Mr. Belcham visited the observatory on his way to Port Blair: he had the aneroid pencil-point sharpened, as it was again recording too faintly. He also adjusted the lever of the pendulum of the tide-gauge clock, which he found out of adjustment and which had been the cause of the clock stopping in January

Chittagong.—I am much obliged to Mr. Good, the Port Officer at this station, for having sent me personally observed tidal values for comparison with the values contained in the tide-tables. The comparisons have been made for the year 1894, and both as regards times and heights are very satisfactory.

Akyab.—At this station Commander Brownlow, Royal Indian Marine, kindly continues supplying me with the tidal comparison tables that his predecessor, Commander Bishop, Royal Indian Marine, used to send to this office. He supplies me with personally observed tidal values for comparison with the values contained in the tide-tables. During 1894 his observations for height accord very closely, and his observations for time accord fairly well with the corresponding values contained in the tide-tables. According to his observations the tide-tables appeared to be about 15 minutes too early during 1894, and during 1895 they seem rather closer to actuality up to the present The errors, however, may possibly be less than this in reality, for reasons similar to those given at the end of the paragraph on the Bhávnagar observations.

Diamond Island.—This island is situated at the entrance of the Bassein river about 5 miles S. S. E. from Pagoda Point. It is a low-lying island about a mile long and covered with trees.

The construction of the observatory has been described in previous reports. The following is a brief description of it as it now stands. A detailed description with plans, etc., drawn up on the spot at the time of starting the observations is filed in this office.

The observatory is situated near high-water mark about fifteen yards north-east of the boat house opposite the small bay on the south-east side of the island and about 60 yards south-east of the flag-staff: it is approximately in latitude 15° 16′ N., longitude 94° 87′ E. It consists of a wooden cabin framed on to eight iron-wood posts set in cement in footings cut in the rock. The lower portions of these posts are firmly braced together by horizontal and diagonal ties. The cabin is 12 feet square and 7 feet high at the eaves, and its floor is about 6 feet above the present level of the sand that covers the rock. A well in the rock receives the float-cylinder which is a large one; 4 feet in diameter and 18 feet long. The well is 8 feet deep and reaches 3 feet below the lowest tides. The cylinder is provided with an iron ladder inside for cleaning purposes and for attending to the sluice that admits the water into it near the bottom. The space between the top of the cylinder and the floor of the observatory (about 3 feet 4 inches), is boarded in and a door is provided to enable a man to get into the cylinder. The communication pipe is a very long one: it is 254 feet long from the float-cylinder to the strainer at its seaward end: it is made up of 3 inch (internal diameter) iron pipe in seven-foot lengths; for about 120 feet from the cylinder it is carried through a cutting in the rock. The remainder is supported on iron uprights and the outward end is secured to an iron frame carrying a beacon intended to keep boats at a safe distance. The great length of communication pipe necessitates special flushing arrangements and special arrangements for locating the position of any obstruction that might interfere with the free passage of the water. A special cylinder serves these purposes: it is similar to the float-cylinder, but only 15 feet in length; it is placed 84 feet from the float-cylinder and having the communication pipe passing through it and capable of discharge into it by means of a sluice: it thus divides the pipe into two sections, and it can be at once ascertained in which section any obstruction is situated, while the facilities it affords for powerful flushing of all parts of the pipe considerably diminish the chance of any obstruction ever occurring. A graduated staff is set up on the beacon and the agreement of the levels of the water in the float-cylinder and the water at the beacon is carefully observed every day to make certain that no retardation occurs.

The tide-gauge is one of Adie's new pattern instruments and numbered 28: it is working on one-third the natural scale: the observations were started on the 30th December 1894. An aneroid and a mercurial barometer are set up in the tidal observatory, and an anemometer is working on the top of a small wooden house built on purpose to receive it and situated close to the meteorological observatory.

Two bench-marks of reference have been embedded in blocks of masonry in the vicinity of the observatory and another inscribed on the steps of the Telegraph Office.

The observatory is in charge of Mr. W. Skinner, Telegraph Master at Diamond Island, who performs the duties of attending to the various instruments and transmitting their records to Poona: he is interested in the work and thoroughly efficient.

The observations to the end of the year under report were quite satisfactory. Several unimportant interruptions occurred in the working of the tide-gauge: the clock ran down three times and its driving weight cord broke once: on seven occasions the pencil failed to mark the curve: the registrations had also to be stopped to clean out the cylinder. But none of these interruptions lasted more than a few hours, and they are all quite insignificant and readily disposed of by interpolation.

The aneroid barometer only failed once, when its driving clock ran down: it was restarted within a few hours: the thermometer attached to this instrument got out of order soon after the operations were started; but the corresponding record can be obtained from the meteorological observatory.

The anemometer failed once owing to rain-water getting into its mechanism and causing it to give no velocity record: once also the spirals were left out of adjustment and the day's record was lost.

Special thanks are due to Mr. D. Joscelyne, Superintending Engineer, 1st Circle, Rangoon, for his co-operation since the erection of the tidal observatory was undertaken; to Mr. T. Harman-Tyndall, Executive Engineer, Bassein Division, until late in 1894, who actually carried out the difficult and laborious engineering work involved in the design: and to Mr. W. A. Moran, the present Executive Engineer, who completed the observatory, afforded every assistance to Mr. Belcham when the observations were being started, and now maintains the observatory and communication pipe, etc. in proper repair, visiting it occasionally during his periodical inspections of the buildings on the island and receiving the Telegraph Master's reports as to repairs, etc.

Rangoon.—At this station the tide-gauge worked well, except between the 16th and 26th October, when the driving clock stopped eight times, the interruptions so caused ranging from a few minutes to sixteen hours; the clock was then removed and attended to by a local watch-maker who set it going again within a few hours, and since then, though its rate was rather irregular till the inspection in January, there were no further failures.

The aneroid barometer failed on two occasions only, but at the inspection it was found that the recording pencil was not working properly owing to the hair spring being very dirty and rusty: the teeth of the recording drum also, which gear into those of the cog-wheel driven by the clock, were noticed to be much worn. A spare aneroid barometer from Elephant Point observatory was examined and found to have a good drum, but to be otherwise inferior to that in use, so the drums were exchanged; to avoid the risk of stoppages caused by the vibration of the observatory, the instrument together with the mercurial barometer was set up in the time ball observatory. Since then the instrument has only stopped twice, for about 10 hours each time.

The anemometer record was much interrupted owing to the clock getting out of order. The first stoppage occurred on the 26th December: after being restarted by the clerk the clock stopped again after seventeen hours, the local watch-maker took it in hand and refixed it on the 3rd January; it stopped again on the 10th February and then began to stop every day: on the 13th it was made over to the watch-maker again, he started it again on the 23rd, but it only worked for three weeks, he tried to get it to work properly, but failed so the Vice-Chairman of the Port Commissioners telegraphed to Poona on the 13th March for another clock; the new clock arrived and was started on the 2nd May: since then there have been only two failures, each lasting about twelve hours.

The observatory was inspected by Mr. Belcham between the 21st and the 29th January: the several instruments were carefully cleaned and put into good working order. Mr. Belcham found that the clerk had put an extra weight of several pounds on to the driving weight of the tide-gauge clock on the 12th January 1894: this was probably the cause of the clock getting out of order; the hair-spring attachment pin was found loose, affecting the rate. A new float-band was attached to the tide-gauge. The position of the pencil relatively to the drum was altered by one foot so as to prevent the extraordinary low tides causing the pencil to pass beyond the bottom of the diagram.

The aneroid barometer was adjusted as mentioned above, and the anemometer cleaned. The mercurial barometer and rain-gauge were found in good order.

It was mentioned in last year's Annual Report that it might be advantageous to isolate the observatory from shocks by severing the rigid connection between the observatory and the long bridge leading to the shore; but this step was not considered advisable by the Port Engineer and Mr. Belcham agreed with him. The bracing of the observatory structure, however, was strengthened: the removal of the aneroid and mercurial barometers to the time ball observatory has been mentioned: and as the tide-gauge clock is a spring

clock with five years' good record it is hoped that the vibration still remaining will not affect the observations.

I am much obliged to Mr. Darlington, Vice-Chairman of the Port Commissioners, and to Mr. Clementson, the Port Engineer, for their co-operation.

Moulmein.—Captain Dodd, the Port officer at this station, has for nearly ten years been sending to this office monthly statements of the actual times and heights of high and low-water observed daily under his direction, compared with the predicted values in the tide-tables: special thanks are due to him for his long-continued assistance.

In 1894, the average errors both in time and height remained unchanged from what they were in the preceding year; but an improvement in the months of June, July and August was noticed in the Annual Report: in these months the predictions of height which had been much too high and therefore dangerous for some years, were much nearer the truth; details are given in the successive Annual Reports; in October, however, owing to the exceptionally long-continued rain-fall the water was much higher than was predicted, the predictions were about 2 feet too low at high water and 4 feet at low water: but these errors are on the safe side.

In 1895 up to the end of July the rain-fall was distinctly below the average. Consequently the predictions are as much too high as they were in the years previous to 1894. During the latter half of July the high-water predictions were too high in some cases by nearly 2 feet, while the low-water predictions ranged from about 2½ feet to 4 feet too high. In August the average excess of the predicted low-waters was 2 feet 11 inches. The comparisons between the actual and the predicted tidal values taken at the tidal stations are sent regularly to Mr. Roberts, and I regret that the improvement during part of 1894 appears to have been due to the lateness of the rain-fall, and not, as suggested last year, to his modifications in the predictions based on the comparisons with actuality.

Mergui.—At this station Mr. H. G. Batten, the Deputy Commissioner of Mergui, has kindly undertaken, as mentioned in last year's Annual Report, to communicate to this office from time to time any cases he may notice in which the predictions contained in the tide-tables do not agree with the actuals observed by means of the graduated staff or tide-pole set up there at the close of the observations in 1894. No such reports have been received up to date.

Port Blair.—At this station the tidal observations have been satisfactory. In June during one of the periodical cleanings of the float-cylinder the float-band broke: it was at once repaired and the interruption only lasted an hour and a half. In July the driving clock got out of order: it stopped on nine occasions: but on each occasion it was restarted within a few hours, so completion by interpolation of the broken curves is easy. On the 19th August the clerk reported that a slight earthquake was felt at 8·35 P.M.: the tidal curve remained normal.

Of the auxiliary instruments the aneroid barometer worked without any interruption till the inspection in February: but Mr. Belcham then found it was entirely out of order and could be made to read any thing between 29·7 inches and 30·3 inches by tapping the case of the instrument: it could not be put in order locally, so Mr. Belcham brought it to Poona: another instrument will be placed in the observatory at the next inspection.

The anemometer worked steadily throughout the year: its driving clock got slightly out of order on two occasions, on each of which two days' record was lost. The mercurial barometer, sun-dial and rain-gauge remained in good order.

In accordance with Colonel Hill's request, referred to in the last Annual Report, an assistant clerk was appointed to provide against illness of the clerk, etc., at this isolated station. His name is Tulshiram and he was instructed in his duties by Mr. Belcham at the time of the inspection. The clerk Mohamed was employed on tidal work at other parts of island in August, and on the 1st of the month Tulshiram relieved him of the work at the observatory. Mohamed will return to his usual post at the end of this month.

At the inspection of the observatory in February, Mr. Belcham found the instruments in good order except that the aneriod record had been worthless, as explained above, and that the anemometer was working stiffly for want of proper oiling of the various bearings. The sun-dial observations taken in January did not accord with the known rate of the chronometer and led Mr. Belcham to think that the clerk had let it run down and then restarted it without reporting the circumstance; but the clerk denied this. The instruments were all cleaned and left, with the exception of the aneroid barometer which was removed as explained above in good working order.

Mr. Brookes, 2nd Assistant Superintendent, Port Blair, has had the supervision of the tidal observatory during the past thirteen years: special thanks are due to him for the great assistance he has thus afforded to the operations.

At all the tidal observatories without exception the operations have been very successful during the year under report; and at the present date the work is proceeding most satisfactorily.

Reduction of the Tidal Observations and extra Tidal work.

The observations for one year at 11 tidal stations have been reduced, and the tabulated values of the tidal constants so obtained are appended. A table showing the variation in height of the sea-level from the general mean height at all the permanent and closed tidal observatories for each calendar year of the tidal operations was given last

year. Two specimen tables of monthly mean sea-levels evaluated from the tidal computations are appended. These and the corresponding tables for thirty-two other ports calculated up to the end of 1893 are preserved for reference in this office. They are discussed above and form a very interesting and valuable record and basis for investigations. The computations for each tidal observatory commence now on January 1st.

With regard to the commencement made tentatively towards utilising the meteorological records of the tidal observatories for tidal purposes, the matter still remains in the postponed condition remarked upon in previous reports.

The present state of the ordinary tidal computations is shown in the table given below, together with their state at the end of September 1893. The letters A. P. in the table indicate that the actual times and heights of high and low-water have been measured from tidal diagrams or graduated staves and compared with their predicted values published in the tide-tables. The actual amount of the usual work done during the year under report can thus be seen at a glance.

Values of the Tidal Constants, Aden, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=5·827 feet.

S_1	H=R=	·102	M_6	R=	·011	Q_1	R=	·131	T_2	R=	·016
	κ= ζ=	179°·72		ζ=	288°·44		ζ=	204°·89		ζ=	238°·42
S_2	H=R=	·654		H=	·013		H=	·111		H=	·016
	κ= ζ=	243°·88		κ=	338°·88		κ=	29°·59		κ=	238°·54
S_4	H=R=	·005	M_8	R=	·001	L_2	R=	·043	$(MS)_4$	R=	·009
	κ= ζ=	261°·09		ζ=	200°·56		ζ=	144°·92		ζ=	32°·62
S_6	H=R=	·007		H=	·001		H=	·035		H=	·010
	κ= ζ=	219°·70		κ=	27°·82		κ=	234°·78		κ=	169°·44
S_8	H=R=	·001	O_1	R=	·773	N_2	R=	·413	$(2SM)_2$	R=	·024
	κ= ζ=	213°·69		ζ=	90°·18		ζ=	203°·47		ζ=	229°·58
				H=	·654		H=	·429		H=	·025
				κ=	37°·02		κ=	218°·14		κ=	92°·77
M_1	R=	·007	K_1	R=	1·446	λ_2	R=	...	$2N_2$	R=	·080
	ζ=	119°·45		ζ=	204°·20		ζ=	...		ζ=	294°·28
	H=	·005		H=	1·300		H=	...		H=	·084
	κ=	223°·87		κ=	34°·87		κ=	...		κ=	186°·79
M_2	R=	1·476	K_2	R=	·233	ν_2	R=	·054	$(M_2N)_4$	R=	·059
	ζ=	89°·30		ζ=	34°·68		ζ=	245°·79		ζ=	54°·56
	H=	1·532		H=	·177		H=	·056		H=	·064
	κ=	226°·12		κ=	235°·99		κ=	281°·78		κ=	206°·04
M_3	R=	·018	P_1	R=	·399	μ_2	R=	·050	$(M_2K_1)_3$	R=	·019
	ζ=	5°·81		ζ=	222°·67		ζ=	271°·40		ζ=	121°·02
	H=	·019		H=	·399		H=	·053		H=	·018
	κ=	211°·03		κ=	31°·67		κ=	185°·04		κ=	88°·51
M_4	R=	·014	J_1	R=	·056	R_2	R=	...	$(2M_2K_1)_3$	R=	·003
	ζ=	41°·92		ζ=	70°·37		ζ=	...		ζ=	276°·34
	H=	·015		H=	·048		H=	...		H=	·003
	κ=	315°·55		κ=	22°·49		κ=	...		κ=	359°·30

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·021	223°·67	·024	345°·82
„ Fortnightly „ . . .	·068	308·82	·047	11·94
Luni-Solar „ „ . . .	.009	38·25	·009	261·43
Solar-Annual „ . . .	·352	67·40	·352	348·40
„ Semi-Annual „ . . .	.157	299·15	·157	141·15

Values of the Tidal Constants, Maskat, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Maskat; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=7·693 feet.

S_1	H = R =	·109	M_6	R =	·008	Q_1	R =	·136	T_2	R =	·082
	κ = ζ =	187°·72		ζ =	347°·64		ζ =	208°·26		ζ =	0°·49
S_2	H = R =	·774		H =	·009		H =	·115		H =	·082
	κ = ζ =	306°·84		κ =	40°·85		κ =	34°·41		κ =	0°·65
S_4	H = R =	·003	M_8	R =	·004	L_2	R =	·058	$(MS)_4$	R =	·012
	κ = ζ =	301° 83		ζ =	53°·53		ζ =	211°·26		ζ =	140°·95
S_6	H = R =	·003		H =	·004		H =	·047		H =	·013
	κ = ζ =	206°·57		κ =	244°·48		κ =	301°·54		κ =	278°·69
S_8	H = R =	·002	O_1	R =	·788	N_2	R =	·491	$(2SM)_2$	R =	·011
	κ = ζ =	10°·62		ζ =	92°·98		ζ =	240°·24		ζ =	244°·15
				H =	·667		H =	·510		H =	·011
				κ =	40°·78		κ =	256°·32		κ =	106°·41
M_1	R =	·014	K_1	R =	1·419	λ_2	R =	...	$2N_2$	R =	·071
	ζ =	158°·20		ζ =	209°·00		ζ =	...		ζ =	329°·22
	H =	·010		H =	1·276		H =	...		H =	·074
	κ =	263°·07		κ =	39°·64		κ =	...		κ =	223°·65
M_2	R =	1·991	K_2	R =	·252	ν_2	R =	·063	$(M_2N)_4$	R =	·075
	ζ =	138°·70		ζ =	99° 07		ζ =	279°·25		ζ =	75°·11
	H =	2·067		H =	·191		H =	·065		H =	·081
	κ =	276°·43		κ =	300°·31		κ =	316°·59		κ =	228°·93
M_3	R =	·024	P_1	R =	·392	μ_2	R =	·031	$(M_2K_1)_3$	R =	·021
	ζ =	100°·07		ζ =	227°·04		ζ =	308°·51		ζ =	179°·16
	H =	·026		H =	·392		H =	·034		H =	·020
	κ =	306°·67		κ =	36°·08		κ =	223°·99		κ =	147°·54
M_4	R =	·006	J_1	R =	·055	R_2	R =	...	$(2M_2K_1)_3$	R =	·003
	ζ =	103°·54		ζ =	81°·24		ζ =	...		ζ =	268°·26
	H =	·006		H =	·048		H =	...		H =	·003
	κ =	19°·01		κ =	32°·83		κ =	...		κ =	353° 10

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·028	290°·80	·032	52°·45
„ Fortnightly „	·056	301·39	·039	3·52
Luni-Solar „ „	·017	343·61	·018	205·87
Solar Annual „	·107	185·81	·107	106·77
„ Semi-Annual „	·145	344·89	·145	186 82

Values of the Tidal Constants, Bushire, 1894-95.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894-95 observations at Bushire; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894-95 observations:—

Short Period Tides.

A_0=4·769 feet.

S_1	H = R =	·075	M_6	R =	·005	Q_1	R =	·120	T_2	R =	...
	κ = ζ =	20°·54		ζ =	127°·15		ζ =	21°·38		ζ =	...
S_2	H = R =	·437		H =	·005		H =	·101		H =	...
	κ = ζ =	259°·54		κ =	267°·25		κ =	221°·41		κ =	...
S_4	H = R =	·004	M_8	R =	·004	L_2	R =	·047	$(MS)_4$	R =	·017
	κ = ζ =	39°·61		ζ =	293°·96		ζ =	320 81		ζ =	53°·63
S_6	H = R =	·004		H =	·004		H =	·043		H =	·017
	κ = ζ =	141°·58		κ =	0°·76		κ =	230°·01		κ =	340°·33

Short Period Tides—contd.

A_0=4·769 feet.

S_8	H =		·001	O_1	R =		·799	N_2	R =		·245
	R =				ζ =		250°·56		ζ =		40°·93
	κ =	ζ =	249°·44		H =		·676		H =		·254
					κ =		235°·81		κ =		182°·41
M_1	R =		·039	K_1	R =		1·167	λ_2	R =		...
	ζ =		327°·49		ζ =		334°·88		ζ =		...
	H =		·024		H =		1·048		H =		...
	κ =		163°·72		κ =		276°·26		κ =		...
M_2	R =		1·128	K_2	R =		·190	ν_2	R =		·095
	ζ =		283°·23		ζ =		185°·92		ζ =		175°·78
	H =		1·171		H =		·145		H =		·098
	κ =		209°·93		κ =		248°·67		κ =		174°·38
M_3	R =		·017	P_1	R =		·298	μ_2	R =		·018
	ζ =		323°·20		ζ =		210°·33		ζ =		353°·73
	H =		·018		H =		·298		H =		·019
	κ =		33°·25		κ =		268°·95		κ =		207°·13
M_4	R =		·012	J_1	R =		·017	R_2	R =		...
	ζ =		95°·06		ζ =		142°·73		ζ =		...
	H =		·013		H =		·015		H =		...
	κ =		308°·46		κ =		229°·41		κ =		...

$(2SM)_2$	R =		·008	$2N_2$	R =		·048	$(M_2K_1)_3$	R =		·064
	ζ =		78°·11		ζ =		124°·13		ζ =		194°·68
	H =		·008		H =		·050		H =		·060
	κ =		151°·41		κ =		120°·39		κ =		62°·76
$(M_2N)_4$	R =		·054					$(2M_2K_2)_3$	R =		·056
	ζ =		241°·09						ζ =		112°·60
	H =		·058						H =		·054
	κ =		309°·27						κ =		24°·63

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·117	302°·61	·134	87°·83
„ Fortnightly „	·024	85·70	·017	221·92
Luni-Solar „ „	·061	248·78	·063	322·08
Solar-Annual „	·210	120·08	·210	151·46
„ Semi-Annual „	·147	130·15	·147	192·0

Values of the Tidal Constants, Karachi, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Karachi; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=7·217 feet.

S_1	H =		·100	M_6	R =		·040	Q_1	R =		·139
	R =				ζ =		157°·22		ζ =		212°·74
	κ =	ζ =	190°·13		H =		·045		H =		·118
S_2	H =		·950		κ =		212°·12		κ =		39°·77
	R =			M_8	R =		·008	L_2	R =		·085
	κ =	ζ =	324°·30		ζ =		83°·29		ζ =		226°·64
S_4	H =		·013		H =		·010		H =		·070
	R =				κ =		276°·48		κ =		317°·19
	κ =	ζ =	13°·29	O_1	R =		·781	N_2	R =		·593
S_6	H =		·008		ζ =		98°·24		ζ =		258°·85
	R =				H =		·661		H =		·615
	κ =	ζ =	287°·95		κ =		46°·63		κ =		275°·79
S_8	H =		·002	K_1	R =		1·460	λ_2	R =		...
	R =				ζ =		215°·82		ζ =		...
	κ =	ζ =	243°·44		H =		1·313		H =		...
M_1	R =		·015		κ =		46°·44		κ =		...
	ζ =		116°·06	K_2	R =		·323	ν_2	R =		·068
	H =		·011		ζ =		118°·09		ζ =		295°·31
	κ =		221°·21		H =		·246		H =		·071
M_2	R =		2·472		κ =		319°·29		κ =		333°·47
	ζ =		155°·79								
	H =		2·566								
	κ =		294°·09								

T_2	R =		·027	$(MS)_4$	R =		·041	$2N_2$	R =		·100
	ζ =		338°·28		ζ =		196°·85		ζ =		347°·36
	H =		·027		H =		·042		H =		·104
	κ =		338°·46		κ =		335°·15		κ =		242°·94
$(2SM)_2$	R =		·019					$(M_2N)_4$	R =		·081
	ζ =		243°·44						ζ =		83°·86
	H =		·020						H =		·088
	κ =		105°·14						κ =		239°·10

Short Period Tides—contd.

A_0=7·217 feet.

M_3	R =	·038	P_1	R =	·392	μ_2	R =	·031	$(M_2K_1)_3$	R =	·032
	ζ =	132°·58		ζ =	232°·83		ζ =	22°·93		ζ =	151°·46
	H =	·040		H =	·392		H =	·033		H =	·030
	κ =	340°·02		κ =	41°·89		κ =	299°·52		κ =	120°·38
M_4	R =	·031	J_1	R =	·055	R_2	R =	...	$(2M_2K_1)_3$	R =	·025
	ζ =	65°·96		ζ =	90°·11		ζ =	...		ζ =	274°·94
	H =	·033		H =	·047		H =	...		H =	·024
	κ =	342°·55		κ =	41°·37		κ =	...		κ =	0°·92

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·052	299°·89	·060	61°·25
„ Fortnightly „	·047	291·28	·032	352·80
Luni-Solar „ „	·029	346·91	·030	208·61
Solar Annual „	·027	100·96	·027	21·90
„ Semi-Annual „	·118	327·39	·118	169·27

VALUES OF THE TIDAL CONSTANTS, BOMBAY (APOLLO BANDAR), 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Bombay (Apollo Bandar); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations :—

Short Period Tides.

A_0=10·237 feet.

S_1	H = R =	·081	M_6	R =	·010	Q_1	R =	·135	T_2	R =	·060
	κ = ζ =	199°·97		ζ =	358°·67		ζ =	215°·26		ζ =	10°·83
S_2	H = R =	1·549		H =	·011		H =	·114		H =	·060
	κ = ζ =	5°·06		κ =	54°·77		κ =	42°·92		κ =	11°·03
S_4	H = R =	·015	M_8	R =	·005	L_2	R =	·076	$(MS)_4$	R =	·123
	κ = ζ =	230°·55		ζ =	89°·48		ζ =	258°·54		ζ =	265°·75
S_6	H = R =	·003		H =	·006		H =	·062		H =	·128
	κ = ζ =	182°·05		κ =	284°·29		κ =	349°·27		κ =	44°·45
S_8	H = R =	·001	O_1	R =	·783	N_2	R =	·932	$(2SM)_2$	R =	·030
	κ = ζ =	188°·75		ζ =	99°·31		ζ =	295°·69		ζ =	267°·45
				H =	·662		H =	·967		H =	·031
				κ =	48°·12		κ =	313°·25		κ =	128°·75
M_1	R =	·013	K_1	R =	1·564	λ_2	R =	...	$2N_2$	R =	·154
	ζ =	68°·99		ζ =	215°·19		ζ =	...		ζ =	2°·15
	H =	·010		H =	1·406		H =	...		H =	·160
	κ =	174°·34		κ =	45°·79		κ =	...		κ =	258°·57
M_2	R =	3·843	K_2	R =	·499	ν_2	R =	·067	$(M_2N)_4$	R =	·075
	ζ =	192°·70		ζ =	157°·71		ζ =	329°·16		ζ =	139°·43
	H =	3·989		H =	·379		H =	·070		H =	·081
	κ =	331°·40		κ =	358°·87		κ =	7°·91		κ =	295°·70
M_3	R =	0·78	P_1	R =	·401	μ_2	R =	·157	$(M_2K_1)_3$	R =	·095
	ζ =	187°·01		ζ =	233°·66		ζ =	35°·47		ζ =	217°·23
	H =	·083		H =	·401		H =	·169		H =	·089
	κ =	35°·07		κ =	42°·74		κ =	312°·88		κ =	186°·53
M_4	R =	·122	J_1	R =	·067	R_2	R =	...	$(2M_2K_1)_3$	R =	·068
	ζ =	62°·73		ζ =	101°·04		ζ =	...		ζ =	343°·62
	H =	·132		H =	·058		H =	...		H =	·066
	κ =	340°·14		κ =	52° 08		κ =	...		κ =	70°·42

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·055	273°·14	·063	34·28
„ Fortnightly „ . . .	·100	295·97	·069	357·05
Luni-Solar „ „ . . .	·055	276·49	·057	137·79
Solar-Annual „ . . .	·102	30·57	·102	311·49
„ Semi-Annual „ . . .	·138	5·95	·138	207·80

VALUES OF THE TIDAL CONSTANTS, BOMBAY (PRINCE'S DOCK), 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Bombay (Prince's Dock); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=8·247 feet.

S_1	H = R =	·092	M_6	R =	·004	Q_1	R =	·135	T_2	R =	·070
	κ = ζ =	198°·45		ζ =	79°·00		ζ =	215°·28		ζ =	18°·10
S_2	H = R =	1·587		H =	·005		H =	·114		H =	·070
	κ = ζ =	3°·72		κ =	135°·10		κ =	42°·94		κ =	18°·29
S_4	H = R =	·020	M_8	R =	·002	L_2	R =	·095	$(MS)_4$	R =	·119
	κ = ζ =	223°·38		ζ =	74°·06		ζ =	244°·83		ζ =	261°·45
S_6	H = R =	·005		H =	·002		H =	·078		H =	·124
	κ = ζ =	187°·28		κ =	268°·86		κ =	335°·56		κ =	40°·15
S_8	H = R =	·004	O_1	R =	·777	N_2	R =	·955	$(2SM)_2$	R =	·035
	κ = ζ =	160°·64		ζ =	98°·68		ζ =	294°·88		ζ =	264°·04
				H =	·657		H =	·991		H =	·036
				κ =	47°·48		κ =	312°·44		κ =	125°·34
M_1	R =	·015	K_1	R =	1·554	λ_2	R =	...	$2N_2$	R =	·156
	ζ =	46°·67		ζ =	214°·35		ζ =	...		ζ =	3°·84
	H =	·011		H =	1·397		H =	...		H =	·162
	κ =	152°·02		κ =	44°·95		κ =	...		κ =	260°·26
M_2	R =	3·893	K_2	R =	·500	ν_2	R =	·083	$(M_2N)_4$	R =	·084
	ζ =	191°·01		ζ =	155°·61		ζ =	325°·28		ζ =	130°·79
	H =	4·041		H =	·380		H =	·086		H =	·090
	κ =	329°·72		κ =	356°·77		κ =	4°·03		κ =	287°·05
M_3	R =	·077	P_1	R =	·389	μ_2	R =	·163	$(M_2K_1)_3$	R =	·090
	ζ =	182°·36		ζ =	233°·59		ζ =	39°·58		ζ =	227°·67
	H =	·082		H =	·389		H =	·175		H =	·084
	κ =	30°·42		κ =	42°·66		κ =	316°·98		κ =	196°·97
M_4	R =	·113	J_1	R =	·063	R_2	R =	...	$(2M_2K_1)_3$	R =	·066
	ζ =	52°·89		ζ =	°101·06		ζ =	...		ζ =	335°·62
	H =	·122		H =	·054		H =	...		H =	·064
	κ =	330°·29		κ =	52°·09		κ =	...		κ =	62°·43

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·064	278°·94	·073	40°·08
„ Fortnightly „ . . .	·114	296·30	·079	357·39
Luni-Solar „ „ . . .	·054	275·34	·056	136·64
Solar-Annual „ . . .	·184	11·42	·184	292·34
„ Semi-Annnal „ . . .	·154	356·86	·154	1·9871

Values of the Tidal Constants, Minicoy, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Minicoy; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=5·200 feet.

S_1	H=R=	·039	M_6	R=	·002	Q_1	R=	·073	T_2	R=	·013
	κ= ζ=	199°·98		ζ=	333°·44		ζ=	226°·94		ζ=	258°·69
S_2	H=R=	·352		H=	·002		H=	·062		H=	·013
	κ= ζ=	19°·94		κ=	29°·58		κ=	54°·63		κ=	258°·89
S_4	H=R=	·003	M_8	R=	·003	L_2	R=	·035	$(MS)_4$	R=	·005
	κ= ζ=	107°·10		ζ=	48°·01		ζ=	282°·56		ζ=	283°·09
S_6	H=R=	·002		H=	·004		H=	·029		H=	·005
	κ= ζ=	230°·19		κ=	242°·88		κ=	13°·30		κ=	61°·81
S_8	H=R=	·001	O_1	R=	·401	N_2	R=	·172	$(2SM)_2$	R=	·004
	κ= ζ=	126°·87		ζ=	110°·74		ζ=	283°·24		ζ=	54°·64
				H=	·339		H=	·179		H=	·004
				κ=	59°·56		κ=	300°·83		κ=	275°·92
M_1	R=	·003	K_1	R=	·769	λ_2	R=	...	$2N_2$	R=	·021
	ζ=	90°·72		ζ=	221°·33		ζ=	...		ζ=	6°·04
	H=	·002		H=	·692		H=	...		H=	·022
	κ=	196°·07		κ=	51°·93		κ=	...		κ=	262°·49
M_2	R=	·825	K_2	R=	·123	ν_2	R=	·035	$(M_2N)_4$	R=	·017
	ζ=	190°·80		ζ=	174°·20		ζ=	320°·95		ζ=	148°·60
	H=	·857		H=	·094		H=	·037		H=	0·18
	κ=	329°·52		κ=	15°·36		κ=	359°·73		κ=	304°·90
M_3	R=	·008	P_1	R=	·211	μ_2	R=	·005	$(M_2K_1)_3$	R=	·008
	ζ=	321°·12		ζ=	243°·11		ζ=	139°·03		ζ=	232°·98
	H=	·009		H=	·211		H=	·006		H=	·007
	κ=	169°·19		κ=	52°·18		κ=	56°·46		κ=	202°·30
M_4	R=	·009	J_1	R=	·031	R_2	R=	...	$(2M_2K_1)_3$	R=	·003
	ζ=	114°·55		ζ=	96°·57		ζ=	...		ζ=	64°·44
	H=	·010		H=	·026		H=	...		H=	·003
	κ=	31°·98		κ=	47°·59		κ=	...		κ=	151°·27

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·020	206°·49	·023	327°·62
„ Fortnightly „	·072	296·28	·050	357·35
Luni-Solar „ „	·012	233·32	·012	94·60
Solar-Annual „	·378	78·24	·378	359·16
„ Semi-Annual „	·133	38·33	·133	240·18

Values of the Tidal Constants, Trincomalee, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Trincomalee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

A_0=1·962 feet.

S_1	H= R=	·016	M_6	R=	·004	Q_1	R=	·008	T_2	R=	·020
	κ= ζ=	87°·05		ζ=	59°·62		ζ=	315°·53		ζ=	193°·04
S_2	H= R=	·231		H=	·004		H=	·007		H=	·020
	κ= ζ=	259°·09		κ=	117°·43		κ=	144°·09		κ=	193°·26
S_4	H= R=	·006	M_8	R=	·002	L_2	R=	·011	$(MS)_4$	R=	·011
	κ= ζ=	126°·69		ζ=	219°·29		ζ=	85°·84		ζ=	131°·35
S_6	H= R=	·002		H=	·002		H=	·009		H=	·011
	κ= ζ=	151°·70		κ=	56°·37		κ=	176°·83		κ=	270°·62

Short Period Tides—contd.

$A_0 = 1{\cdot}962$ feet.

S_8	H =	R =	·000	O_1	R =	·073	N_2	R =	·151	$(2SM)_2$	R =	·019
	κ =	ζ =	26°·57		ζ =	357°·80		ζ =	210°·80		ζ =	358° 14
					H =	062		H =	·156		H =	·019
					κ =	307°·20		κ =	229°·23		κ =	218° 87
M_1	R =		·008	K_1	R =	·247	λ_2	R =	...	$2N_2$	R =	030
	ζ =		153°·11		ζ =	141°·03		ζ =	...		ζ =	343°·32
	H =		·006		H =	·222		H =	...		H =	·032
	κ =		258°·74		κ =	331° 61		κ =	...		κ =	240°·92
M_2	R =		·494	K_2	R =	·077	ν_2	R =	·041	(M_2N_4)	R =	·031
	ζ =		103°·45		ζ =	52°·30		ζ =	353°·02		ζ =	42°·79
	H =		513		H =	·059		H =	·042		H =	·033
	κ =		242°·72		κ =	253°·42		κ =	32°·60		κ =	200°·49
M_3	R =		·002	P_1	R =	·073	μ_2	R =	·020	$(M_2K_1)_3$	R =	·007
	ζ =		352°·57		ζ =	170°·53		ζ =	208°·61		ζ =	127°·67
	H =		003		H =	073		H =	·022		H =	·007
	κ =		201°·47		κ =	339°·62		κ =	127°·15		κ =	97°·51
M_4	R =		·013	J_1	R =	·013	R_2	R =	...	$(2M_2K_1)_3$	R =	·006
	ζ =		276°·65		ζ =	16°·74		ζ =	...		ζ =	233°·34
	H =		·014		H =	·011		H =	...		H =	·005
	κ =		195°·19		κ =	327°·45		κ =	...		κ =	321°·31

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·019	257°·83	·022	18°·66
„ Fortnightly „ . . .	·055	310·58	038	11·05
Luni-Solar „ „ . . .	·016	83·25	·017	303·98
Solar-Annual „ . . .	·255	335 71	·255	256·61
„ Semi-Annual „ . . .	·220	283 84	·220	125·64

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations:—

Short Period Tides.

$A_0 = 11{\cdot}383$ feet.

S_1	H =	R =	·089	M_6	R =	·119	Q_1	R =	·015	T_2	R =	·105
	κ =	ζ =	193°·33		ζ =	275°·46		ζ =	166°·63		ζ =	194°·45
S_2	H =	R =	1·514		H =	·133		H =	·012		H =	105
	κ =	ζ =	98°·36		κ =	334° 71		κ =	355°·95		κ =	194°·69
S_4	H =	R =	·100	M_8	R =	·051	L_2	R =	·221	$(MS)_4$	R =	·678
	κ =	ζ =	111°·74		ζ =	102°·81		ζ =	347°·59		ζ =	298°·16
S_6	H =	R =	·004		H =	·059		H =	·181		H =	·704
	κ =	ζ =	59°·04		κ =	301°·81		κ =	78°·80		κ =	77°·91
S_8	H =	R =	·001	O_1	R =	·223	N_2	R =	·571	$(2SM)_2$	R =	·080
	κ =	ζ =	341°·57		ζ =	71° 81		ζ =	26° 34		ζ =	144°·23
					H =	·189		H =	·593		H =	·083
					κ =	21°·71		κ =	45°·52		κ =	4°·48
M_1	R =		·053	K_1	R =	·443	λ_2	R =	...	$2N_2$	R =	·148
	ζ =		194°·22		ζ =	224°·62		ζ =	...		ζ =	128°·23
	H =		·039		H =	399		H =	...		H =	·154
	κ =		300°·09		κ =	55°·17		κ =	...		κ =	26°·82

Short Period Tides—contd.

A=11·383 feet.

M_2	R =	3·427	K_2	R =	·508	ν_2	R =	·114	$(M_2N)_4$	R =	·137
	ζ =	277°·62		ζ =	248°·27		ζ =	0°·96		ζ =	242°·35
	H =	3·557		H =	·386		H =	119		H =	·147
	κ =	57°·37		κ =	89°·35		κ =	41°·25		κ =	41°·28
M_3	R =	051	P_1	R =	·145	μ_2	R =	·268	$(M_2K_1)_3$	R =	·131
	ζ =	122°·19		ζ =	239°·22		ζ =	260°·83		ζ =	55°·89
	H =	·054		H =	·145		H =	·289		H =	·123
	κ =	331°·81		κ =	48°·34		κ =	180°·33		κ =	26°·20
M_4	R =	681	J_1	R =	·017	R_2	R =	...	$(2M_2K_1)_3$	R =	·055
	ζ =	118°·91		ζ =	40° 83		ζ =	...		ζ =	235° 60
	H =	·734		H =	·014		H =	...		H =	·053
	κ =	38°·41		κ =	351°·26		κ =	...		κ =	324°·54

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·200	269°·38	·229	29°·96
„ Fortnightly „	·317	330 ·18	·218	30 14
Luni-Solar „ „	·825	184 ·79	·856	45·04
Solar-Annual „	3·378	241 ·19	3·378	162·07
„ Semi-Annual „	1·118	153 ·39	1·118	355·16

Values of the Tidal Constants, Rangoon, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Rangoon ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations :—

Short Period Tides.

A_0=10·152 feet.

S_1	H= R =	·106	M_6	R =	·199	Q_1	R =	·005	T_2	R =	·053
	κ = ζ =	135°·92		ζ =	15°·44		ζ =	172°·48		ζ =	131°·84
S_2	H= R =	2·305		H =	·222		H =	·005		H =	·053
	κ = ζ =	168°·33		κ =	76°·28		κ =	2°·64		κ =	132°·10
S_4	H= R =	·085	M_8	R =	·070	L_2	R =	·389	$(MS)_4$	R =	·414
	κ = ζ =	254° 43		ζ =	242° 50		ζ =	66°·84		ζ =	63°·57
S_6	H= R =	·014		H =	·081		H =	·320		H =	·430
	κ = ζ =	45°·29		κ =	83° 63		κ =	158°·31		κ =	203° 85
S_8	H= R =	·003	O_1	R =	·339	N_2	R =	1·019	$(2SM)_2$	R =	·203
	κ = ζ =	113°·43		ζ =	68°·36		ζ =	93°·74		ζ =	186° 53
				H =	·286		H =	1·057		H =	·211
				κ =	18°·81		κ =	113°·73		κ =	46°·24
M_1	R =	·030	K_1	R =	·776	λ_2	R =	...	$2N_2$	R =	·327
	ζ =	53°·13		ζ =	202°·25		ζ =	...		ζ =	228°·45
	H =	·022		H =	·697		H =	...		H =	·340
	κ =	159°·26		κ =	32°·78		κ =	...		κ =	128°·14
M_2	R =	5·889	K_2	R =	·735	ν_2	R =	·206	$(M_2N)_4$	R =	·166
	ζ =	348°·77		ζ =	325°·43		ζ =	84°·50		ζ =	279°·43
	H =	6·113		H =	·558		H =	·214		H =	·179
	κ =	129°·05		κ =	166°·47		κ =	125°·57		κ =	79°·70
M_3	R =	·029	P_1	R =	·177	μ_2	R =	·533	$(M_2K_1)_3$	R =	·168
	ζ =	171°·56		ζ =	247°·24		ζ =	5°·86		ζ =	88°·91
	H =	·031		H =	·177		κ =	·574		κ =	·156
	κ =	21°·98		κ =	56°·38		H =	286°·43		H =	59° 73
M_4	R =	·379	J_1	R =	·013	R_2	R =	...	$(2M_2K_1)_3$	R =	·120
	ζ =	238°·93		ζ =	183°·16		ζ =	...		ζ =	314°·27
	H =	·427		H =	·011		H =	...		H =	·117
	κ =	159°·49		κ =	133° 28		κ =	...		κ =	44°·30

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·178	263°·24	·204	23°·53
„ Fortnightly „ . . .	·195	311·17	·134	10·55
Luni Solar „ „ . . .	·492	188·54	·511	48·25
Solar-Annual „ . . .	1·346	224·96	1·346	145·82
„ Semi-Annual „ . . .	·230	159·28	·230	1·00

Values of the Tidal Constants, Port Blair, 1894.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1894 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1894 observations :—

Short Period Tides.

A_0=4·742 feet.

S_1	H = R =	·021	M_6	R =	·004	Q_1	R =	·009	T_2	R =	·037
	κ = ζ =	99°·83		ζ =	288°·97		ζ =	61°·70		ζ =	308°·12
S_2	H = R =	·961		H =	·004		H =	·008		H =	·037
	κ = ζ =	315°·59		κ =	349°·12		κ =	251°·49		κ =	308°·38
S_4	H = R =	·003	M_8	R =	·003	L_2	R =	·102	$(MS)_4$	R =	·016
	κ = ζ =	288°·44		ζ =	252°·90		ζ =	208°·27		ζ =	100°·34
S_6	H = R =	·002		H =	·004		H =	·084		H =	·016
	κ = ζ =	217°·88		κ =	93°·10		κ =	299°·63		κ =	240°·36
S_8	H = R =	·001	O_1	R =	·181	N_2	R =	·368	$(2SM)_2$	R =	·026
	κ = ζ =	116°·57		ζ =	354°·59		ζ =	251°·96		ζ =	280°·44
				H =	·153		H =	·382		H =	·027
				κ =	304°·80		κ =	271°·59		κ =	140°·39
M_1	R =	·012	K_1	R =	·437	λ_2	R =	...	$2N_2$	R =	·065
	ζ =	138°·12		ζ =	136°·99		ζ =	...		ζ =	347°·83
	H =	·009		H =	·393		H =	...		H =	·067
	κ =	244°·14		κ =	327°·53		κ =	...		κ =	247°·05
M_2	R =	1·910	K_2	R =	·316	ν_2	R —	·037	$(M_2N)_4$	R =	·070
	ζ =	140°·19		ζ =	109°·29		ζ =	270°·62		ζ =	77°·62
	H =	1·983		H =	·240		H =	·039		H =	·076
	κ =	280°·24		κ =	310°·34		κ =	311°·35		κ =	237°·30
M_3	R =	005	P_1	R =	·128	μ_2	R =	·073	$(M_2K_1)_3$	R =	·019
	ζ =	169°·38		ζ =	160°·15		ζ =	34°·22		ζ =	224°·55
	H =	·005		H =	·128		H =	·079		H =	·017
	κ =	19°·46		κ =	329°·28		κ =	314°·32		κ =	195°·15
M_4	R =	·007	J_1	R =	·013	R_2	R =	...	$(2M_2K_1)_3$	R =	·002
	ζ =	259°·02		ζ =	358°·21		ζ =	...		ζ =	165°·96
	H =	·008		H =	·011		H =	...		H =	·002
	κ =	179°·12		κ =	308°·47		κ =	...		κ =	255°·52

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·025	200°·30	·029	320°·71
„ Fortnightly „	·078	319·79	·054	19·42
Luni-Solar „	·006	333·02	·006	192·97
Solar-Annual „	·227	236·78	·227	157·65
„ Semi-Annual „	·073	313·17	·073	154·90

Table showing the values of mean sea-level in feet above the zero of the gauge at Aden for every calendar month from the commencement of the tidal observations in 1879 to the end of 1893: mean range at springs being 6·7 feet.

	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet	feet.
January	...	5·733	6·023	5·865	6·023	6·114	6·088	6·075	6·184	6 078	6·042	6 016	5·868	5·918	6·070
February	...	6·086	6·093	6·079	5·968	5·992	6·074	6·115	5 946	6 142	6·049	6·081	6 014	6 086	5·996
March	6·083	6·021	6 096	6·098	6·001	6·058	6·159	6·198	6·063	5 998	6·155	6 147	6·131	5·922	6·175
April	6 207	6 070	6·046	6·115	6·114	6·109	6·247	6·194	6·046	6 153	6·143	6·189	6·184	6·237	6 172
May	6·149	6·078	6·189	6·058	6·111	6·231	6 254	6·329	6·198	6·131	6 131	6·221	6·167	6·171	6·041
June	5·869	5·942	5·819	5·699	5 836	5·911	6·179	6·198	5·860	5·958	5·872	5·860	5 879	6·045	5·966
July	5·557	5·621	5·823	5·323	5·429	5·620	5·688	5·834	5·542	5·682	5·675	5·459	5·579	5·594	5·747
August	5·304	5·262	5·355	5·412	5·405	5·499	5·429	5·450	5·318	5·517	5·301	5·224	5·397	5·339	5·357
September	5·387	5·370	5·402	5·486	5·429	5·407	5·243	5·371	5·320	5·459	5·520	5·467	5·436	5·561	5·290
October	5·454	5·472	5·476	5 386	5·534	5·516	5·472	5·589	5·476	5·599	5·551	5·417	5·662	5·616	5·421
November	5·600	5·552	5·720	5·580	5·745	5·668	5·793	5·687	5·788	5·889	5·628	5·687	5·884	5·714	5·476
December	5·787	5 858	5·897	5·917	5·873	5·978	5·932	5·830	6·025	5·833	5 921	5·927	5·834	5·846	5·966

Highest monthly value = 6·329. Lowest monthly value = 5·224. General Mean = 5·822.

Table showing the values of mean sea-level in feet above the zero of the gauge at Kidderpore for every calendar month from the commencement of the tidal observations in 1881 to the end of 1893: mean range at springs being 11·7 feet.

	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
	feet.	feet.	feet	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
January	...	8·864	8·622	8·747	8·838	9·082	9·098	8·816	8·993	9·006	8·577	8·631	8·644
February	...	8·502	8·436	8·686	8·533	8·724	8·888	8·513	8·449	9 104	8·526	8·590	8·216
March	8·498	8·870	8·919	9·066	9·115	8·926	9·362	9·152	8·967	9·147	8 872	9·280	8·838
April	9·210	9·006	9·578	9·421	9·171	9·558	9·723	9·850	9·470	9·756	9·454	10·113	9·575
May	9·873	9 656	10·070	9·959	9·475	9·999	10·646	10·063	10·283	10·002	9·946	10·254	10·395
June	10·635	10·761	10·634	10 230	10·370	10·916	11·550	10·297	10·923	11·227	10·997	10·428	11·413
July	12·183	12·715	12·127	11·816	12·562	13·101	12·890	12·046	13·061	14·006	11·799	12·470	14 099
August	14·241	13·731	13·561	13·440	14·803	14·859	14·409	14·930	14·380	16·256	13·726	13·835	14·899
September	14·381	13·802	13·433	13·375	15·769	15·799	14 841	15 255	15·469	15·356	13·952	14·716	15·010
October	12·953	12·985	11·532	12·803	12·701	14·215	12·641	11·989	12 968	13·095	12·133	12·201	13·552
November	10·321	10·308	10·058	10·737	10·386	11·325	10·462	9·981	11·225	10·731	10·407	10·445	11·102
December	8 9/9	9·430	9·512	9·752	9·326	9·813	9·485	9·142	9·779	9·237	9·075	9·222	9·869

Highest monthly value = 16·256. Lowest monthly value = 8 216. General Mean = 10·944.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1894-95.

Tidal Observatory.	State at end of September 1894.	State at end of September 1895.
ADEN	1893 calculations completed A. P. 1893.	1894 calculations completed. A. P. 1894.
MASKAT . . .	1893-94 calculations completed.	1894 calculations completed.
BUSHIRE . . .	1892-93 calculations completed .	1894-95 calculations completed.
KARACHI . . .	1893 calculations completed. A. P. 1893.	1894 calculations completed. A. P. 1894.
BHÁVNAGAR . .	1893 calculations completed. A. P. 1893.	A. P. 1894.
BOMBAY (Apollo Bandar).	1893 calculations completed. A. P. 1893.	1894 calculations completed. A. P. 1894.
BOMBAY (Prince's Dock).	1893 calculations completed A. P. 1893.	1894 calculations completed. A. P. 1894.
COCHIN . . .	A. P. 1893	A. P. 1894.
MINICOY . . .	1893 calculations completed A. P. 1893.	1894 calculations completed. A. P. 1894.
TUTICORIN . . .	A. P. 1893.	A. P. 1894.
COLOMBO . . .	A. P. 1893.	A. P. 1894.
TRINCOMALEE . .	1893 calculations completed. A. P. 1893.	1894 calculations completed. A. P. 1894.
MADRAS . . .	. . . . .	Observations resumed on 23rd November 1894. A. P. 1894 (December).
KIDDERPORE . .	1893 calculations completed. A. P. 1893.	1894 calculations completed. A. P. 1894.
CHITTAGONG . .	A. P. 1893.	A. P. 1894.
AKYAB . . .	A. P. 1893.	A. P. 1894.
RANGOON . . .	1893 calculations completed. A. P. 1893	1894 calculations completed. A. P. 1894.
MOULMEIN . . .	A. P. 1893.	A. P. 1894.
MERGUI . . .	1893-94 calculations completed. A. P. 1893.	
PORT BLAIR . .	1893 calculations completed. A. P. 1893.	1894 calculations completed. A. P. 1894.

The extra tidal and levelling work is not entered in the table. This consisted:—

(*a*) In continuing the testing of Professor G. H. Darwin's new apparatus for facilitating and abridging the reduction of tidal observations: comparing tide-tables and executing calculations in the manner and with the results indicated above;

(*b*) in supplying the Engineer to the Port Trust Bombay with the comparisons of actual and predicted tides at Prince's Dock, Bombay, for 1890, 1891, 1892, 1893, and 1894 to enable him to pursue an investigation of the question whether the recent dredging has affected the time the tide turns;

(*c*) in discussing with the Officer in charge of the Marine Survey of India Department the best method of reducing certain tidal observations taken under his orders at Kenkesanturai: in analysing those observations after plotting them in diagram form for interpolation of gaps in the observations in proving that Indian Spring Low-Water Mark cannot be evaluated from observations extending over short periods;

(*d*) in completing and submitting for publication a chart (on Mercator's Projection) of the Tidal and Levelling Operations, showing approximate cotidal lines;

(*e*) in tabulating, examining and discussing the monthly mean-sea-levels at thirty-four tidal stations up to the end of 1893, thus giving a basis for investigations of the question of the seasonal variation at sea-level;

(*f*) in submitting reports on the operations carried on in the Bombay Presidency and in Burma to the local Governments;

(*g*) in arranging for comparing the working of the meteorological instruments at the tidal stations with standards kept working at Poona: this involved erecting two anemometer sheds, starting experiments of simultaneous working of instruments, etc.

(*h*) in re-levelling for verification the levelling between the standard Bench-mark at the Light-house, Madras, and the Bench-mark at the Prince of Wales' memorial Stone, to prove that the latter had not been disturbed by the immense loads passing near it for the Harbour Works.

The following table gives particulars of the Tidal Diagrams sent for safe custody to the Surveyor-General's Office, Calcutta: this table is in continuation of that given on page xxxix of the Appendix to the General Report, 1891-92.

Particulars of the completed tidal diagrams sent for safe custody to the Surveyor-General's Office, Calcutta, are given in the following table:—

Tidal Observatory.	Serial number and date of tidal diagram.
Aden	No. 321, dated 21st February 1887 to No. 526, dated 22nd October 1894.*
Karachi	No. 226, dated 14th February 1887 to No. 310, dated 19th May 1890.*
	No. 327, dated 29th December 1890 to No. 404, dated 25th December 1893.
Bhavnagar . . .	Complete series from No. 1, dated 2nd December 1885 to No. 227, dated 1st July 1894.
Mormugao . . .	No. 55, dated 1st January 1886 to No. 90, dated 4th January 1887. (Series completed).
Cochin	No. 138, dated 30th December 1889 to No. 242, dated 20th March 1892. (Series completed.)
Tuticorin	No. 72, dated 7th October 1889 to No. 106, dated 9th June 1890.
Kidderpore . . .	No. 158, dated 17th March 1884 to No. 338, dated 24th March 1890.*
	No. 391, dated 21st March 1892 to No. 411, dated 9th January 1893.*
	No. 437, dated 25th December 1893 to No. 462, dated 24th December 1894.
Rangoon	No. 283, dated 1st March 1886 to No. 414, dated 9th March 1891.*
Moulmein . . .	No. 59, dated 12th April 1884 to No. 130, dated 24th April 1886.*
Amherst	No. 185, dated 12th August 1885.*
Mergui	No. 21, dated 23rd December 1889 to No 136, dated 6th June 1894. (Series completed.)
Port Blair . . .	No. 157, dated 16th April 1883 to No. 379, dated 20th September 1891. (Old series.)*
	No. 1, dated 30th January 1892 to No. 27, dated 6th February 1893. (New series.)

* The other diagrams are kept for the present in Poona.

THE TIDE-TABLES.

In addition to the calculations already mentioned, the usual work has been done in connection with the issue of the tide-tables for 1895 (which, on arrival at this office from London, were at once distributed) and with the preparation of those for 1896. The tide-tables were again issued late this year. They arrived in two lots, the first on the 27th December 1894, and the second as late as the 3rd January 1895. Colonel Hill, in the last Annual Report, to which I would invite a reference (p. lv of the Appendix), drew attention to the great inconvenience that arises from the tide-tables, which ought certainly to reach the ports they predict for by the beginning of the new year, coming year after year so much behind time that the public are put to inconvenience and the Government to loss (through the sale of non-official tide-tables locally to supply the demand). The tide-tables ought to reach this office in November, in order that they may be forwarded to the more remote stations by the time they are needed there. The delay appears to be due to the necessity of passing the tide-tables through the Store Department of the India Office in London. In the Appendix to the General Report for 1892-93 (p. xxxii) it is mentioned that the Surveyor-General and Deputy Surveyor-General expressed the opinion that a change in the manner of issuing the tide-tables was desirable. Colonel Hill suggested last year that Mr. Roberts be authorised to dispense with the intervention of the Store Department and to forward the tide-tables to this office direct, immediately they are printed and bound. The supply could then easily reach this office early in November: and, in order to protect the Government sale, copies ought either not to be procurable by the public in London or elsewhere before the same time, or all rights in the tables should be reserved to the Government or the official vendors.

In connection with the tide-tables for 1896, the values of the constants, calculated in the usual manner, were sent to Mr. Roberts ready for use in the Tide-Predictor: and, in addition, he was furnished with the actual values during 1894, of every high and low-water at eleven stations measured, in duplicate, from the tidal diagrams, together with tidal observations for the same year taken daily during daylight from graduated staves or tide-poles at the sites of the Bhávnagar, Cochin, Tuticorin, Colombo, Chittagong, Akyab and Moul-

mein tidal observatories, kindly supplied with great regularity by tne Port officials. In order to save Mr. Roberts the labour of the calculation, all the predicted times and heights of high and low-water for 1894 at these stations were compared with the above-mentioned actual values and the errors tabulated, thus giving him in a convenient form information capable of assisting him materially in improving the predictions. An improvement in the predictions for the riverain stations during the period of the south-west monsoon has always been a desideratum, but unvarying accuracy at that season of the year seems unattainable, owing to the impossibility of making a true forecast of the rainfall, which has a great influence on the level of the river water. The riverain stations at which the accuracy of the predictions has been tested are Kidderpore, Rangoon, Moulmein and Chittagong. At Kidderpore up to the beginning of June and in the month of December the actuals accorded well with the predictions, the heights agreeing on the average within about 8 inches and the times within about 15 minutes; but during the middle and the latter part of the south-west monsoon the heights actually measured exceeded the predicted heights by quantities rapidly increasing up to 3½ feet in July, then diminishing until at the beginning of August the predictions were correct, or a trifle too high; then increasing again steadily till the beginning of September, when the excess was 3 feet; then diminishing again but rather suddenly increasing for the last time to the greatest excess of all in the beginning of November, when the predictions were 4 feet too low. As a rule, the excess was greater at low-water than at high, as is usual, but in November this was not the case at the time of the greatest differences. At the end of November the effect of the rainfall was over and the agreement became very good. As these errors are all on the safe side, and as the rainfall of 1894 was exceptionally long continued in its effects, it is doubtful whether it would be safe to increase the predicted heights in the manner the above differences would suggest. At Rangoon the actual and predicted heights showed a distinct tendency for several low tides in each month to be predicted over a foot and a half, and in many cases up to as much as two and half feet too high: this is particularly dangerous and should be rendered impossible in the future The high tides were satisfactory. In January, February and March the time predictions were distinctly late, about 15 minutes on the average; the same fault was observed in July and August: for the other months they were close to the truth. Regarding Moulmein and Chittagong nothing requires notice beyond what has already been mentioned in the paragraphs devoted to those stations.

The datum for the tide-tables for 1896 is the datum of soundings in the latest charts. Tables giving the particulars of the datum at each tidal station were printed at page lii of the Appendix to the General Report for 1891-92 and at page lvi of that for 1893-94.

The tide-tables for 1896 will contain predictions for 35 tidal stations. The amount realised by the sale of the tide-tables in the financial year 1894-95 is Rs. 346 less than was realised in the preceding financial year: and the limited number of presentation copies were distributed in strict accordance with the lists sanctioned by Government.

The usual tabular statements are appended, showing the percentage and amount of the errors in the predicted times and heights of high and low-water for the year 1894 at 18 stations as determined by comparison of the predictions entered in the tide-tables for that year with actual values measured from the tidal diagrams at 12 stations and from graduated staves or tide-poles at 6 stations; the former measurements being made by assistants in my office and the latter by Port officers' subordinates.

No. 1.

Statement showing the percentage and the amount of the errors in the Predicted Time of High Water at the various Tidal Stations for the year 1894.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	647	20	44	15	13	2
Karachi	698	36	45	10	6	3
Bnávnagar	393	29	44	9	13	5
Bombay { Apollo Bandar	705	34	41	12	9	4
Bombay { Prince's Dock	701	29	43	13	11	4
Cochin	299	14	26	18	35	7
Tuticorin	362	96	2	...	1	1
Minicoy	688	30	38	13	11	8
Colombo	233	56	20	8	10	6
Trincomalee	675	14	24	11	14	37
Madras	75	...	...	3	25	72
Kidderpore	704	23	34	13	18	12
Chittagong	364	39	40	10	8	3
Akyab	365	26	48	19	7	...
Rangoon	694	21	35	14	22	8
Moulmein	365	35	39	11	10	5
Mergui	302	49	35	5	6	5
Port Blair	703	43	46	6	4	1

No. 2.

Statement showing the percentage and the amount of the errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1894.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	628	30	44	11	11	4
Karachi	702	35	44	8	8	5
Bhávnagar	381	21	36	14	12	17
Bombay { Apollo Bandar	706	28	43	11	12	6
Bombay { Prince's Dock	700	37	41	9	8	5
Cochin	259	19	26	19	32	4
Tuticorin	363	99	1	...	...	...
Minicoy	687	26	40	13	11	10
Colombo	243	51	21	5	15	8
Trincomalee	678	13	23	9	15	40
Madras	75	1	4	4	35	56
Kidderpore	705	20	37	12	19	12
Chittagong	365	33	39	10	12	6
Akyab	365	11	42	28	19	...
Rangoon	696	20	32	11	17	20
Moulmein	365	32	36	9	15	8
Mergui	302	26	37	15	15	7
Port Blair	705	44	43	7	4	2

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1894.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	647	6·7	93	7	...	...
Karachi	698	9·3	72	24	4	...
Bhávnagar	393	31·4	37	31	19	13
Bombay { Apollo Bandar	705	13·9	72	24	4	...
Bombay { Prince's Dock	701	13·9	70	26	4	...
Cochin	299	3·2	84	16	...	...
Tuticorin	362	3·2	100	...	...	...
Minicoy	688	4·0	93	7	...	...
Colombo	233	2·6	89	10	1	...
Trincomalee	675	2·1	87	10	3	...
Madras	75	3·5	93	7	...	...
Kidderpore	704	11·7	34	20	17	29
Chittagong	364	13·3	37	24	14	25
Akyab	365	8·3	90	10	...	...
Rangoon	694	16·4	51	27	14	8
Moulmein	365	12·7	37	24	15	24
Mergui	302	18·1	69	23	5	3
Port Blair	703	6·6	95	5	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1894.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	628	6·7	93	7	...	...
Karachi	702	9·3	75	22	3	...
Bhávnagar	381	31·4	20	21	20	39
Bombay { Apollo Bandar	706	13 9	69	28	3	...
Bombay { Prince's Dock	700	13·9	69	27	4	...
Cochin	2 9	3·2	100	...	...	...
Tuticorin	363	3·2	100	...	...	...
Minicoy	687	4·0	96	4	...	...
Colombo	243	2·6	86	14	...	...
Trincomalee	678	2·1	84	16	...	...
Madras	75	·5	79	20	...	1
Kidderpore	705	11·7	30	21	15	34
Chittagong	305	13·3	48	25	14	13
Akyab	365	8 3	78	20	1	1
Rangoon	696	16·4	16	17	24	43
Moulmein	365	12·7	33	24	13	30
Mergui	302	18·1	42	43	14	1
Port Blair	705	6·6	94	6	...	...

No. 5.

Table of Average Errors in the predicted times and height of high and low water at the several Tidal Stations for the year 1894.

Stations.	Mean Range at springs in feet.	Average Errors.					
		Of time in minutes.		Of height in terms of the range.		Of height in inches.	
		H. W	L. W.	H. W.	L. W.	H. W.	L. W.
Open Coast.							
Aden	6·7	12	11	·025	·025	2	2
Karachi	9·3	10	11	·027	·027	3	3
Bhávnagar	31·4	12	17	·019	·029	7	11
Bombay { Apollo Bandar	13·9	11	13	·018	·018	3	3
Bombay { Prince's Dock	13·9	12	11	·018	·018	3	3
Cochin	3·2	18	16	·078	·026	3	1
Tuticorin	3·2	2	2	·026	·026	1	1
Minicoy	4·0	13	14	·042	·042	2	2
Colombo	2·6	8	10	·064	·096	2	4
Trincomalee	2·1	32	34	·079	·119	2	3
Madras	3·5	36	33	·048	·071	2	3
Akyab	8·3	11	15	·020	·023	2	3
Mergui	18·1	9	15	·014	·030	3	5
Port Blair	6·6	8	8	·025	·025	2	2
General Mean		14	15	·036	·041		
Riverain.							
Kiderpore	11·7	16	17	·071	·085	10	12
Chittagong	13·3	10	12	·050	·044	8	7
Rangoon	16·4	15	18	·030	·061	6	12
Moulmein	12·7	11	13	·052	·066	8	10
General Mean		13	15	·051	·064		

The foregoing statements for the year 1894 may thus be summarised :—

Percentage of time predictions within 15 minutes of actuals.

			High water. Per cent.	Low water. Per cent.
Open coast stations.	10 at which predictions were tested by	S. R. tide-gauge	65	62
	4 " " "	tide-pole	72	67
Riverain stations.	2 " " "	S. R. tide-gauge	56	55
	2 " " "	tide pole	77	70

Percentage of height predictions within 8 inches of actuals.

			High water. Per cent.	Low water. Per cent.
Open coast stations.	10 at which predictions were tested by	S. R. tide-gauge	95	92
	4 " " "	tide-pole	100	100
Riverain stations.	2 " " "	S. R. tide-gauge	66	42
	2 " " "	tide-pole	61	65

Percentage of height predictions agreeing within one-tenth of mean range at springs.

			High water. Per cent.	Low water. Per cent.
Open coast stations.	10 at which predictions were tested by	S. R. tide-gauge	97	95
	4 " " "	tide-pole	91	93
Riverain stations.	2 " " "	S. R. tide-gauge	88	80
	2 " " "	tide-pole	86	84

In this summary the tests are of two classes, the first and more accurate class being those made by means of self-registering tide-gauges and the second being made by means of tide-poles. I have mentioned in the paragraph on Bhávnagar that while height readings (except in rough weather) can be accurately taken from a tide-pole, corresponding time readings, owing to the rough nature of the appliance and the chance of inaccuracy in the local time, must be allowed a considerable margin of error. The predictions for time, although not equal to those for height, are undoubtedly very good, and the figures taken as a whole show a high standard of general accuracy.

BENCH-MARKS.

During the year under report the following bench-marks and survey stations were connected in the course of the regular levelling operations :—One standard bench-mark for Calcutta, 37 ordinary embedded bench-marks, 365 ordinary or inscribed bench-marks, 7 bench-marks of reference of tidal observatories, 31 railway bench-marks, 5 Public Works Department bench-marks, and 4 Great Trigonometrical Survey stations.

In connection with the re-starting of the tidal observations at Madras 1 embedded and 3 inscribed bench-marks of reference for the tidal observatory were connected with the bed-plate of the tide-gauge.

In connection with the starting of the tidal observations at Diamond Island 2 embedded and 1 inscribed bench-marks of reference and 2 Marine Survey bench-marks were connected with the bed-plate of the tide-gauge.

At Madras bench-marks Nos. 4 and 5,—section Madras to Arkonam, Spirit-levelled Heights No. 1, Madras Presidency, seasons 1869-85, were reconnected by double-levelling with bench-mark No. $\frac{1}{2}$ of the same section, the standard bench-mark for Madras, in order to make certain that they had not been disturbed by the passing of immense loads along the road close by them in the course of the Harbour works. They were found not to have been disturbed, but bench-mark No. 3 of the same section, $\overset{\text{G. T. S. B.}}{\underset{\text{B. M.}}{\odot}}$ at Master Attendant's house, cut on the step leading into the Master Attendant's office at Madras, was found at a different level from that published in the pamphlet. Bench-marks Nos. 6, 8, 9 $\frac{1}{9}$, $\frac{2}{9}$ of the same section were visited and found in good order, but bench-mark No. 10 $\overset{\text{G. T. S.}}{\underset{\text{B. M.}}{\odot}}$ at Madras Central Railway station, cut on the north-east corner of the central portion of the platform, could nowhere be found and must have been removed. All these bench-marks are given on pages 1 to 3 Spirit-levelled Heights No. 1, Madras Presidency, seasons 1869-85.

Intimation was received from the office of the Surveyor-General that the bench-mark No. 51 (page 46 of Spirit-levelled Heights, Bengal Presidency, etc.) was reported by the Inspector of Diamond Harbour to have been removed.

Bench-mark No. 111 (page 51 of Spirit-levelled Heights No. 4, Madras Presidency) was found by Mr. Bond to have been removed during changes in the landing place at Vizagapatam.

The following "Test Bench-marks" have been selected in connection with the tidal observatories named, their object being to detect secular changes of relative level between the land and the sea. This list is in continuation of that given on page XXXVII of the Appendix of the General Report for 1890-91, and it will be noticed that two test bench-

marks have been selected at Karachi in place of the one previously selected, which is now useless.

List of Test Bench-marks.

Tidal observatory.	Number of Test bench-mark published in pamphlet of Spirit-levelled Heights.	Approximate distance of Test Bench-mark from Observatory.
		Miles.
Karachi	No. 10 of Heights in Karachi and its neighbourhood, 1893-94	7·5
	NOTE—This is the bench-mark of reference for Karachi, and is the principal Test bench-mark for the Karachi Tidal Observatory.	
	The former Test bench-mark inscribed on the top step of the front entrance to Karachi Church (page 38, Tables of Heights in Sind, Punjab, etc., published in 1863, has been condemned as useless, *vide* p.p. v and vi of Heights in Karachi and its neighbourhood. 1893-94.	
	No. 8 of Heights in Karachi and its neighbourhood, 1893-94.	5·8
Mergui	No. 3. Section Mergui to Mergui Base-Line, No. 1 Burma, 1892-93	0·4
	No. 4 ditto ditto ditto	10·3

In connection with the preservation of the bench-marks, Colonel Hill suggested last year in his annual report, to which I would venture to invite a reference (page lx, of the appendix of the General Report, 1893-94), that it would be advantageous if the principle marks of reference, such as pillars of the base-lines, standard bench-marks, and a proportion of the lesser though very important stations and bench-marks of the Great Trigonometrical Survey of India, were to be visited periodically and reported upon by an officer of the Department. He stated that at present the Department is without regular means of verifying the reports upon the survey stations which are submitted by the civil authorities as matter of yearly routine from all quarters of India: and that the destruction or dilapidation of stations and bench-marks is sometimes discovered only by accident. He gave two striking examples of wholesale disappearance of important marks of reference coming within his own recent experience.

No such remarkable discoveries have been made this year, but the matter cannot cease to demand constant attention.

Levelling Operations.

The regular levelling operations were carried out by Mr. J. Bond. The first work to be done was the connection of the Standard Bench-mark for Calcutta, situated within the enclosure of the Survey of India Offices and immediately in front of the Mathematical Instrument Office, with the Kidderpore tidal observatory and with the spirit-levelling executed in field season, 1882-83. This consisted of a line of double-levelling carried from the Kidderpore Tidal Observatory along Garden Reach Road to the Lord Napier of Magdala statue: thence two lines were carried, one across the maidan and along Park Street to determine the value of the Calcutta Standard Bench-mark at which it closed: and one to the Mint connecting as many as possible of the bench-marks laid down in 1882-83. The results indicate a slight settling of the ground in the vicinity of the river; particulars are given in the introduction to the appendix to "Spirit-levelled Heights, Bengal Presidency", in which form the work will shortly be published. The distance levelled over exceeded 6 miles, in the course of which two existing embedded bench-marks, four bench-marks of reference of the Kidderpore tidal observatory, five existing inscribed bench-marks, eight new inscribed bench-marks and the Standard Bench-mark for Calcutta were connected. The levelling staves used at Calcutta could not be compared with 10-foot standard bars at the time of the execution of the work, as contrary to expectation, it was found that no such standard bars are kept in the Mathematical Instrument Office. Arrangements are being made for the comparison of the staves and the results will be appended to the next Annual Report.

The remaining and much more extensive work was the continuation of the line of double-levelling, executed in field season, 1893-94, from Cuttack down the coast *viâ* Khurda and Ganjam, to Berhampur and thence along the open line of the East Coast Railway to Vizagapatam, closing on the bench-marks of reference of the Vizagapatam tidal observatory; thus effecting a connection with the spirit-levelling that was brought northwards to Vizagapatam, in season 1887-88, and completing the junction by spirit-levelling of all the tidal stations along the eastern coast of India. In connection with this line a branch line, 40 miles long, was carried from Khurda along the high-road to Jatni Railway Station, the junction of the proposed railway to Puri and thence *viâ* Pipli to Puri, to form a basis for the rectification of the railway levels and to determine the height above mean-sea-level of points in Puri, and in particular of the

barometer in the Puri meteorological observatory. The levelling was carried over fairly level country till it reached the hills between the Bengal and Madras Presidencies: here the ground was so steep that the instruments had to be set up 130 times in 5 miles of levelling, giving only 100 feet on the average between the instrument and the levelling staff instead of the usual 400 feet in level country; some of the country over which the levelling was carried was rough and hilly, covered with jungle; the connection of the four Great Trigonometrical Stations each involving a long ascent added considerably to the task: their average height is 950 feet.

The total rises and falls for the season including the work at Calcutta amounted to 12,825 feet and the total out-turn to 356½ miles of double-levelling in the course of which the instruments were set up at 3,266 stations and the heights of one standard bench-mark, 37 ordinary embedded bench-marks, 365 ordinary inscribed bench-marks, seven bench-marks of reference of tidal observatories, 31 railway bench-marks, five Public Works Department bench-marks, and four stations of the Great Trigonometrical Survey were determined. This is a good out-turn and very creditable to Mr. Bond, who carried out his work most efficiently. The highly satisfactory character of the levelling thus completed may be estimated by comparing the height of the closing bench-mark at Vizagapatam as derived from the tidal observations at Vizagapatam with its height as derived from the origin of the line of levels at Cuttack near False Point.

The height derived from the origin is only one inch higher than that derived from Vizagapatam; and the distance between the points is 365¼ miles.

Extract from the Report by MR. J. BOND, *Extra Assistant Superintendent, 4th grade, on the levelling operations executed by him, Season 1894-95.*

The levelling detachment as under, proceeded by rail from Poona on the 6th December, and arrived at Calcutta on the 9th.

Levellers { Mr. J. Bond, Extra Assistant Superintendent.
Vinayek Narayan, Surveyor.

Recorders { Sitaram Yeshwant, Sub-Surveyor.
Balwant Atmaram, Sub-Surveyor.

Auxilary Recorder { Govind Ramchandra, Computer.

Work was commenced on the 13th from the Kidderpore tidal observatory, connecting the standard bench-mark and the bench-marks of the levelling executed in field season, 1881-82, and closed on the 18th. On the 20th the party left Calcutta by steamer and arrived at Cuttack on the 22nd. Preliminaries were completed by the 28th and the work from Cuttack to Vizagapatam was commenced. The labour involved in connecting four stations of the Great Trigonometrical Survey was severe, owing to the great height of each station above the main line of levels:.

Barnai H. S. of the East Coast Series is a steep hill densely covered with jungle and rises 853 feet above the ground at its foot.

On the 9th, 10th, and 11th February the party was employed in determining by spirit-levelling the height of Chandikho H. S., a principal station of the East Coast Series. The hill is steep and thickly covered with jungle and rises 1,500 feet above the road-way. This was a heavy and trying piece of work, as owing to the great height of the hill the party had to start long before daybreak and work all day.

By the end of February the party arrived at Berhampur, where arrangements were made with the railway officials for embedding the bench-mark stones at the railway stations in such a position that they would remain undisturbed. Mr. B. P. Wall, Executive Engineer, in charge of the construction length afforded me every assistance.

In connecting Mal H. S., a principal station of the East Coast Series, 480 feet high, a branch line had to be undertaken, extending 5 miles over heavy and rough ground and through a forest of Cashew trees.

The health of the party was good throughout the field season.

I append the usual tabular statement of the out-turn of levelling; also the following tables:—

Table A, giving the Great Trigonometrical Stations connected and the errors of their original heights.

Table B, Railway bench-marks connected on the East Coast Railway line and their errors. The errors of the Public Works Department bench-marks connected this season cannot be ascertained, as the Superintending Engineer, Orissa Circle, states that the values of the bench-marks have not been determined.

In Table I, page lxiv of the appendix to last year's General Report, the figure +1·60 given as the apparent terminal difference in feet of the line of levelling Bombay to False Point should be +1·72, and corresponding resulting error per 100 miles, given as ·13 foot should consequently be ·14. But the correction is so small that it makes no difference in the inferences drawn from the table.

During next field season the levelling operations will commence at Raipur on the direct line between Bombay and False Point and be carried southwards to join the past season's levelling near the Vizagapatam tidal station, connecting with trigonometrical stations of the Bilaspur Meridional Series, and forming the first instalment of the line between Vizagapatam and Allahabad, to which Colonel Hill, in his Annual Report for 1893-94, drew attention as necessary to complete the general scheme of the levelling operations in India.

Tabular Statement of out-turn of work for the field season 1894-95 by the Levelling Detachment under Mr. J. Bond.

During the Month of	Number of Miles Double Levelling.		Total Number of Feet.		Number of stations at which trument was set up.	Number of Bench-marks connected.						
	Main Line.	Branch Line.	Rises.	Falls.		Standard.	Reference.	Embedded.	Inscribed.	G. T. Survey. Station.	Railway.	Public Works Department.
Section Kidderpore Tidal Observatory to Surveyor General's Offices and Mint, Calcutta.												
	M. C. L. feet.	M. C. L. feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
December . .	6 15 10	...	61·690	65·273	88	1	4	2*	13*	...	...	...
Section Cuttack to Vizagapatam.												
December . .	3 39 4	...	85·312	73·302	48	...	...	1	3*	...	...	...
January . . .	61 57 82	3 16 38	2053·556	1292 456	698	...	...	6	70	1	...	4
February . . .	60 11 2	4 56 70	1376·748	2847·912	718	...	...	7	62	1	2	1
March . . .	98 1 0	5 31 85	973·267	1130·628	730	...	...	10	89	1	3	...
April . . .	79 23 6	3 42 77	769·202	1331·068	606	...	3	8	77	1	26	...
Total .	293 51 94	16 67 70	5258·085	6675·366	2800	...	3	32	301	4	31	5
Section Khurda to Puri.												
January . . .	39 70 18	...	334 693	430·459	378	...	...	3	51	...	...	...
GRAND TOTALS .	339 57 22	16 67 70	5654·468	7171·098	3266	1	7	37	365	4	31	5
Total number of miles Double Levelling .	...	356 44 92	Total of rises and falls.	12825·566	...	...	...	...	...	...	...	...

* Includes old bench-marks connected for verification.

Results of comparison of staves—Season 1894-95.

Date of comparison.	Mean difference of length of pairs of staves from 10 feet.	
	Staves B1 and B2.	Staves B3 and B4.
	Feet.	Feet.
Cuttack, 27th December 1894	+·001165	+·001531
Berhampur, 1st March 1895	+·000064	+·000035
Vizagapatam, 26th April 1895	+·000123	—·000214

Table A.

List of Great Trigonometrical Survey Principal Stations of the East Coast Series, connected by spirit-levelling—Season 1894-95.

Name of station.	Height in feet above Mean Sea-level.		Error of height by Triangulation, in feet.	Remarks.
	By spirit-levelling.	By Triangulation.		
Barnai, H. S.	1003	1002	—1	The heights refer to the upper mark, or top surface of pillar, level with the upper mark stone.
Chandikho, H. S.	1518	1517	—1	
Mal H. S.	483	481	—2	
Pindi, H. S.	768	768	...	

Table B.

List of Railway Bench-marks on the East Coast Railway, connected by the Survey of India Levelling Operations.—Season 1894-95.

No.	Bench-marks.	Height above Mean Sea-level at Vizagapatam, in feet.		Error of railway levels, in feet.
		By Survey of India levelling operations.	By Railway levels.	
		Feet.	Feet.	Feet.
133	$\overline{\wedge}$ 99·52 at Chatrapur railway station, on coping of platform, east end	99·76	99·52	0·24
134	$\overline{\wedge}$ 99·54 at Chatrapur railway station, on coping of platform, west end	99·80	99·54	0·26
264	$\overset{112\cdot37}{\wedge}$ at culvert, near telegraph post No. $\frac{288}{8}$ . .	113·90	112·37	1·53
269	$\overset{107\cdot96}{\wedge}$ at bridge, near telegraph post No. $\frac{287}{5}$ . .	109·40	107·96	1·44
270	$\overset{114\cdot67}{\wedge}$ at culvert, near telegraph post No. $\frac{286}{7}$ . .	116·14	114·67	1·47
271	$\overset{126\cdot91}{\wedge}$ at bridge, near telegraph post No. $\frac{285}{17}$ . .	128·28	126·91	1·37
272	$\overset{135\cdot55}{\wedge}$ at bridge near telegraph post No, $\frac{284}{3}$ . .	136·95	135·55	1·40
278	B. M. $\curlyvee$ 255·84 at culvert, near telegraph post No. $\frac{279}{8}$ . .	257·02	255·84	1·18
279	B. M. $\curlyvee$ 267·36 at culvert, near telegraph post No. $\frac{278}{15}$ . .	268·56	267·36	1·20
280	B. M. $\curlyvee$ 284·24 at bridge, near telegraph post No. $\frac{277}{20}$ . .	285·43	284·24	1·19
281	B. M. $\curlyvee$ 318·07 at bridge, near telegraph post No $\frac{275}{22}$ . .	319·21	318·07	1·14
282	B. M. $\curlyvee$ 323·46 at culvert, near telegraph post No. $\frac{275}{7}$ . .	324·68	323·46	1·22
283	B. M. $\curlyvee$ 319·40 at bridge, near telegraph post No. $\frac{273}{16}$ . .	320·54	319·40	1·14
291	B. M. $\curlyvee$ 236·42 at bridge, near telegraph post No. $\frac{267}{18}$ . .	237·68	236·42	1·26
292	B. M. $\curlyvee$ 214·58 at culvert, near telegraph post No. $\frac{266}{22}$ . .	215·92	214·58	1·34
294	B. M. $\curlyvee$ 212·49 at Chodavaramu railway station, on coping of platform opposite home semaphore . .	213·77	212·49	1·28
296	B. M. $\curlyvee$ *85·11 at bridge, near telegraph post No. $\frac{265}{6}$ . .	186·59	*85·11	1·48
297	B. M. $\curlyvee$ 145·38 at bridge, near telegraph post No. $\frac{263}{7}$ . .	146·65	145·38	1·27
298	B. M. $\curlyvee$ 120·04 at bridge, near telegraph post No. $\frac{262}{18}$ . .	122·43	120·94	1·49
299	B. M. $\curlyvee$ 121·61 at bridge, near telegraph post No. $\frac{262}{9}$ . .	123·09	121·61	1·48
300	B. M. $\curlyvee$ 123·74 at culvert, near telegraph post No. $\frac{261}{19}$ . .	125·22	123·74	1·48
302	B. M. $\curlyvee$ 124·60 at culvert, near telegraph post No. $\frac{261}{15}$ . .	126·08	124·60	1·48
303	B. M. $\curlyvee$ 121·37 at culvert, near telegraph post No. $\frac{261}{4}$ . .	123·05	121·37	1·68

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL, DRAWING, AND COMPILATION.

Statement showing the work performed during the year 1894-95.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
ATLAS OF INDIA.			
Sheets Nos. 36 S. W., 39 S. E., 39 S. W., 49 S. E., 49 N. W., 49 S. W., 66, 66 S. E., 67, 67 N. W., 67 S. W., 69 N. E., 69 N. W., 69 S. W., 70, 70 S. E., 76 S. E., 76 S. W., 78, 79, 80, 94, 102, 107, 108, 109, 111, 112, 116, 121, 125 S. E., and 125 N. W.	1=4	32	Additions made to railways, roads, canals, and changes to boundaries.
Sheets Nos. 23 S. E., 24 N. E., 25 N. E., 26 N. E., 20 S. E., 27 N. E., 40 S. W., 41 N. E., 41 S. E., 41 N. W., 41 S. W., 42 N. E., 48 N. W., 58 N. W., 58 S. W., 59 N. E., 59 S. E., 59 N. W., 60 N. E., 68 S. W., 76 N. E., 76 S. W., 77 S. W., and 78 N. W.	1=4	24	Additions made to names and detail for engraving.
Sheets Nos. 23 S. E., 36 S. W., 37 S. W., 38 N. W., 48 N. W., 49 S. W., 61 N. E., 61 S. E., 76 S. W., and 77 N. W.	1=4	10	Hills brush-shaded for engraving.
GENERAL MAPS.			
Afghanistan	1=24	2	Corrections completed.
India (shewing canals)	1=32	6	Brought up to date.
Do. skeleton)	1=32	6	Additions and corrections.
Do.	1=32	6	3rd edition, in progress.
Do.	1=48	4	Railways brought up to date.
Do. (engraved)	1=64	4	Additions and corrections to railways to date.
Do.	1=80	1	Additions to railways to date.
Do. (engraved)	1=96	1	Railways brought up to date.
Do. (do.)	1=128	1	Brought up to date for general report.
Do. (do.)	1=256	1	Brush-shaded hills for engraving.
PROVINCIAL MAPS.			
Bengal, Bihar, Orissa, and Chota Nagpur	1=16	2	Completed and published in outline.
Bengal	1=16	2	Additions and corrections to date.
Bombay (engraved)	1=16	1	Additions to date.
Gujarat	1=16	1	Additions and corrections to date.
His Highness the Nizam's Dominions	1=16	2	Additions to date.
North-Western Provinces and Oudh	1=16	1	Additions to railways to date.
Punjab (engraved)	1=16	4	Additions to date.
Do.	1=16	4	Completed with hills.
Rajputana	1=16	2	Additions to date.
Upper Burma	1=16	2	Completed for photography and published.
Bengal, Bihar, Orissa, and Chota Nagpur, with the Province of Assam	1=64	1	Additions to railways to date.
DIVISIONAL MAPS.			
Chota Nagpur	1=4	8	Completed for photography.
Patna	1=16	1	Additions to date.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
DISTRICT MAPS.			
Bankura Bogra Burdwan Cuttack Dacca Darbhanga Gaya Hazaribagh Hissar Howrah Jhelum Khasi and Jaintia Lohardaga Malda Murshidabad Noakhali Rawalpindi Shahabad Sonthal Parganas Sylhet	1=4	20	Additions and corrections made to date.
STANDARD MAPS.			
BOMBAY—			
Sheet No. 340	1=1	1	Corrections to boundaries completed.
CENTRAL INDIA AND RAJPUTANA—			
Sheets Nos. 396, 409, 421, 429, 431, 450, 480, and 482	1=1	8	Completed and published.
Sheets Nos. 27, 120, 335, 338, 376, 378, 379, 408, 410, 419, 420, 427, 441, 448, 449, 451, 462, and 483	1=1	18	In progress.
CENTRAL PROVINCES—			
Sheets Nos. 22, 24, 25, 29, 30, 31, and 38	1=1	7	Additions to roads.
Sheets Nos. 206, 207, 224, and 225 (in one sheet)	1=2	1	In progress.
HYDERABAD—			
Sheets Nos. 101, 102, 103, 125, 126, and 127 (in one sheet)	1=2	1	Completed and published.
Sheets Nos. 150, 168, 169, and 231	1=1	4	Ditto.
MADRAS—			
Sheet No. 152	1=1	1	Completed and published.
UPPER BURMA AND SHAN STATES—			
Sheets Nos. 312 and 313	1=1	2	In progress.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
STANDARD MAPS—*contd.*			
UPPER BURMA (NORTH-EAST FRONTIER SERIES)—			
Sheet No. 15 S. W. . .	1=4	1	Completed and published.
Sheet No. 15 N. W. . .	1=4	1	In progress.
Sheet No. 15 (4th edition) .	1=8	1	Ditto.
Sheet No. 23 (2nd edition) .	1=8	1	Ditto.
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)—			
Sheet No. 1 N. W. (4th edition)	1=4	1	Completed and published.
Sheet No. 2 N. W. . .	1=4	1	In progress.
Sheet No. 2 S. W. . .	1=4	1	Completed and published.
Sheet No. 3 S. E. . . .	1=4	1	In progress.
Sheet No. 3A. N. E. . .	1=4	1	Ditto.
Sheet No. 1 (5th edition) .	1=8	1	Ditto.
Sheet No. 2 (2nd edition) .	1=8	1	Ditto.
Sheet No. 3A. (2nd edition) .	1=8	1	Completed and published.
Sheet No. 4 (2nd edition) .	1=8	1	In progress.
Sheet No. 5	1=8	1	Ditto.
Sheet No. 6 (2nd edition) .	1=8	1	Ditto.
Sheet No. 7	1=8	1	Corrections made to railways.
Sheet No. 9	1=8	1	In progress.
Sheet No. 10	1=8	1	Ditto.
Sheet No. 13	1=8	1	Ditto.
ADMINISTRATION REPORT MAPS.			
Assam	1=48	1	Corrected to date for engraving.
Bengal	1=80	1	Hills brush-shaded for ditto.
Punjab	1=80	1	Corrected to date for ditto.
BENGAL—			
Cuttack	1=8	1	Hills brush-shaded for engraving.
Darjeeling	1=8	1	Corrections to date for ditto.
Hooghly	1=8	1	Ditto ditto.
Manbhum	1=8	1	Hills brush shaded for ditto.
Midnapur	1=13	1	Ditto d tto.
Patna	1=8	1	Ditto ditto.
Shahabad	1=8	1	Published.
24-Parganas . . .	1=8	1	Additions and corrections to date for engraving.
CENTRAL PROVINCES—			
Balaghat	1=12	1	In progress for engraving.
Damoh	1=8	1	Hills brush-shaded for engraving.
Jubbulpore	1=8	1	Ditto ditto.
Raipur	1=20	1	In progress for engraving.
NORTH-WESTERN PROVINCES—			
Dehra Dun	1=8	1	Corrections to date for engraving.
Jhansi	1=8	1	Ditto ditto.
Unao	1=8	1	Published.
PUNJAB—			
Hissar	1=8	1	Completed for engraving.
Ludhiana	1=8	1	Ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
INDEX MAPS.			
To illustrate progress of field parties	Various	18	Corrected to September 1895.
Province of Madras } Two Provinces of Sind and Bombay. } of each	1=32	4	Ditto.
MISCELLANEOUS MAPS.			
District map of Simla and adjoining Native States	1=4	1	Combined 7 adjoining atlas sheets for litho.
A map of the Viceroy's tour, 1895	1=96	1	Prepared.
PLANS OF CITIES AND CANTONMENTS.			
Plan of Calcutta (engraved)	16=1	9	Corrected to date for engraving.
Map of City and Environs of Mysore	12=1	6	Corrected to date.
WORK DONE FOR OTHER DEPARTMENTS.			
STATISTICAL MAPS.			
India illustrating Canal Systems	1=192	2	Prepared for the Statistical Atlas of India (2nd edition) for the Revenue and Agricultural Department.
Do. do. Languages			
Do. do. Economic Products—			
Sheet I.—Cotton, Wheat, Rice and Barley.	1=384	3	
Sheet II.—Linseed, Jowar, Ginjelly, and Bajra			
Sheet III.—Tea, Jute, Coffee, and Indigo			
Diagram illustrating Total Trade (1 sheet)	...	1	
Diagram illustrating Exports of Raw Produce (1 sheet)	...	1	
Diagram illustrating Finance and Taxation (2 sheets)	...	2	
Diagram illustrating Wholesale Prices (2 sheets)	...	2	
MISCELLANEOUS MAPS.			
Map of Chang Bhakhar State	1=1	1	Completed for Bhya, Chang Bhakhar State.
Map of country 10 miles around Peshawar Church	1=1	1	Ditto Deputy Assistant Adjutant-General, Peshawar.
Map to accompany a Report of Railway Survey between of Assam and Burma	1=2	2	Prepared for Engineer-in-Chief.
Map of country between Lahore and Gujarat	1=2	1	Completed for Deputy Assistant Adjutant General, Lahore.
Map of Bhopal Agency	1=4	9	Colored boundaries for Political Agent, Bhopal.
Map of country 10 miles round Rawalpindi	2=1	2	Prepared for the Adjutant-General, Rawalpindi; proof submitted for approval.
India (water-works)	1=32	6	Completed for Surgeon-Colonel Harvey.
MAPS, COLOURED, ETC.			
Maps on various scales	...	1,500	For Surveyor-General's Office.
Ditto ditto	...	219	For other Departments.

DRAWING OFFICE, CALCUTTA.

SECTION I—*concluded.*

Statement of work—concluded.

Description of Work.	Number of Sheets.
Maps examined.	
Atlas sheets	42
General maps	26
Provincial maps	24
Divisional maps	8
District maps	21
Standard maps	80
Plans of Cities and Cantonments	28
Administration Report maps	22
Index maps	22
Technical charts	4
Statistical and Extra-Departmental maps	32
Miscellaneous maps (Departmental)	74
Office copies of various maps, with additions and corrections in territorial boundaries and public works	172
Tracing prints prepared for Atlas reductions	30
Tracing of roads, canals and railways from originals supplied by P. W. D.	28
Engraved proofs of Atlas sheets in various stages	151
Engraved proofs of General and Provincial maps, including index charts	42
Engraved proofs of large scale plans	26
Engraved proofs of Administration Report maps	79
Litho. proofs of General and Provincial maps, including index charts	53
Litho. proofs of District maps transferred from copper-plates	17
Litho. proofs of Statistical and Extra-Departmental maps	27
Photo. proofs of standard various other maps	343
Colouring of maps for various purposes	638
Projection and examination of graticules and plotting of points	73
TOTAL	2,062

N.B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof sheets of the "Survey of India Notes," as to the correct orthography of geographical names, and various other minor works, have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE DRAWING AND COMPILATION.

Statement showing the work performed during the year 1894-95.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS.	In. M.		
PUNJAB.			
District Peshawar.			
Sheets No. 6 (Portions of new Nos. 79 and 80) . . .	1=1	1	Proofs passed; press order given.
District Hissar.			
Sheets Nos. 243 and 260 . .	1=1	2	Fair maps corrected to date. Proofs passed; press order given.
Indus Riverain Survey.			
Sheets Nos. 23, 24, 25, 26, 27, 41, 42, 43, 45, 46, 47, 48, and 68	1=1	13	Fair maps examined with plane-table sections and corrected. Proofs sent to press for corrections.
NORTH-WESTERN PROVINCES.			
Districts Naini Tal (including portions of late Tarai and Kumaun Districts), Moradabad, Budaun, Bareilly, and Pillibhit and Rampur State.			
Sheets Nos. 47, 48, 49, 50, 64, 65, 66, 67, 81, 82, 83, 84, 98, 99, and 100	1=1	15	Proofs passed; press order given.
District Agra.			
Sheet No. 38 (old No. 6) in 4 sections	2=1	4	Fair maps corrected for reprint.
Districts Fyzabad, Sultunpur, and Jaunpur.			
Sheet No. 178 . . .	1=1	1	Proofs passed; press order given.
Districts Meerut, Moradabad, and Bulandshahr.			
Sheets Nos. 19, 31, 32, and 49 .	1=1	4	Additions and corrections made to roads, railways and boundaries.
District Budaun.			
Sheet No. 68	2=1	1	Ditto ditto.
District Gorakhpur.			
Sheets Nos. 207, 215, and 216 .	1=1	3	Corrections made to boundaries also on 2-inch fair sheets.
OUDH.			
Districts Unao, Lucknow, and Bara Banki.			
Sheets Nos. 104, 105, 106, 107, 120, 121, 122, 123, 134, 135, 136, and 137	1=1	12	Additions and corrections made to boundaries.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
OUDH—contd.			
Districts Gonda and Bahraich.			
Sheets Nos. 147, 148, 149, 158, 159, 160, 161, 162, 172, 173, 174, and 175 . . .	1=1	12	Additions and corrections made to boundaries.
District Kheri.			
Sheets Nos. 113 and 114 . .	1=1	2	Ditto ditto.
BENGAL.			
District Cuttack.			
Killa Kanika.			
Sheets Nos. 223 and 224 . .	1=1	2	Proofs passed; press order given.
District Darjeeling (including British portion.)			
Sheets Nos. 269 and 292 . .	1=1	2	Ditto ditto.
Sheet No. 270	1=1	1	Proofs examined and sent to press for correction.
Districts Darjeeling and Jalpaiguri.			
Sheet No. 293	1=1	1	Ditto ditto.
District Jalpaiguri.			
(Resurveyed portion.)			
Sheets Nos. 293, 294, 295, 315, 316, 317, 337, 338, and 339 .	1=1	9	Ditto ditto.
District Faridpur.			
Sheet No. 7	1=1	1	Additions and corrections made to boundaries.
District Hazaribagh.			
Sheets Nos. 8, 9, 14, and 15	1=1	4	Ditto ditto.
Districts Hooghly and Howrah.			
Sheets Nos. 2, 3, 4, 5, 6, and 7 .	1=1	6	Ditto ditto.
District Midnapur.			
Sheets Nos. 2, 5, and 7 . .	1=1	3	Ditto ditto.
District Mymensingh.			
Sheets Nos. 375, 376, 378, and 388	1=1	4	Proof passed; press order given.
Sheets Nos. 348, 349, 377, 390, and 391	1=1	5	Proofs examined and sent to press for correction.
Sheet No. 389	1=1	1	Proofs await receipts of unpublished prints from the district officials.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
STANDARD MAPS —*continued.*			
CENTRAL PROVINCES.			
District Balaghat.			
Sheets Nos. 11, 18, 19, and 20 .	1=1	4	Additions and corrections made to boundaries.
ASSAM.			
Districts Kamrup, Darrang, and Nowgong.			
Sheets Nos. 26, 27, 39, 40, 50, 51, and 61 (4 sections in each) .	2=1	26	Typed.
District Goalpara.			
Sheet No. 6	1=1	1	Additions and corrections made to boundaries.
District Lakhimpur.			
Sheets Nos. 84, 85, 99, 100, 115, and 131 (4 sections in each .	2=1	12	Completed and held in abeyance for completion to margin.
Districts Sibsagar.			
Sheets Nos. 99, 100, 115, and 131 (4 sections in each) . .	2=1	16	Drawing finished; publication deferred pending receipt of materials from cadastral survey.
BOMBAY.			
Sheets Nos. 160, 167, 168, 169, 174, 175, 224, 227, 228, 242, 270, 275 and 276 . . .	1=1	13	Proofs passed, press order given.
Sheets Nos. 176, 208, 209 and 210 (4 sections in each) . .	2=1	16	Examined with field section, corrected and sent to press for publication.
Sheets Nos. 308 and 309 . .	1=1	2	Completed to margin and corrected. Proofs sent out to district officials.
Sheets Nos. 243, 334, 335, 356, and 337 (4 sections in each) .	2=1	20	Fair maps examined with field sections, corrected and sent to press for publication.
Sheets Nos. 310 and 311 . . .	2=1	2	Being corrected for press.
Sheet No. 273 . . .	1=1	1	Additions and corrections made to boundaries.
LOWER BURMA.			
Sheet No. 231	1=1	1	Proof passed, press order given.
Sheets Nos. 179, 181 and 182 (4 sections in each) . .	2=1	12	Being completed to margin from the 2-inch maps of Burma Provincial Survey for 2nd edition.
District Amherst.			
Sheets Nos. 374, 375 and 376 .	1=1	3	Fair maps corrected and sent to press. Proofs passed, press order given.
Sheets Nos. 419, 426, 427 and 428	2=1	16	Being examined for press.
UPPER BURMA.			
Districts Mandalay and Sagaing.			
Sheet No. 258	1=1	1	Proofs passed, press order given.
Sheets Nos. 259 and 260 . .	1=1	2	Proofs examined and sent to press for corrections.
Sheet No. 261 (4 Sections) .	2 1	4	Examined with field stations and being corrected.

DRAWING OFFICE, CALCUTTA

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
UPPER BURMA—contd.			
District Sagaing.			
Sheets Nos. 166, 167, 168, 213, 214, 215, 216 (4 Sections in each)	2=1	28	Fair maps examined with cadastral plans, corrected and sent to press. Proofs sent out to the district officials for examination.
PARGANA MAPS.			
BENGAL.			
District Bhagalpur.			
Sheet No. 6	1=1	1	Additions and corrections made to boundaries.
District Dacca.			
Main Circuit No. 9 . .	1=1	1	Ditto ditto ditto.
District Hooghly.			
Sheets Nos. 38, 50, 51, 54 and 55	4=1	5	Ditto ditto ditto.
District Patna.			
Sheet No. 1	1=1	1	Ditto ditto ditto.
DISTRICT MAPS.			
PUNJAB.			
Kangra	1=2	4	Additions made to roads and railways.
Gujranwala	1=2	2	Plotted Great Trigonometrical Survey points for a new compilation.
North-Western Provinces and Oudh.			
Mirzapur	1=2	6	Proofs corrected from district officer's proofs.
Garhwal	1=2	6	Publication held in abeyance pending receipt of further order from the local officials.
Almora	1=2	6	Examined and sent to press for publication. Proofs passed, press order given.
Naini Tal	1=2	4	Drawn and sent to press, proofs sent out to district officials.
BENGAL.			
Bhagalpur	1=4	1	Additions and corrections made to boundaries.
Patna	1=4	...	Ditto ditto.
PLANS OF CITIES AND CANTONMENTS.			
Mooltan, country 6 miles round the city	4=1	6	Drawn and sent to the Ex Officer.
Belgaum . . .	6=1	2	Fair maps corrected and sent to press for publication.
Lucknow shewing the British position and the Military operation in 1857 and 1858 . .	3=1	1	Drawn; proof under correction.
Cawnpore	2=1	1	Drawing in progress.
Lucknow . . .	6=1	4	Corrected to date.
Meerut	6=1	4	Do. do.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
MISCELLANEOUS MAPS.	In. M.		
Hooghly River, Sheet No. 1 .	2=1	1	Drawn and sent to press. Proofs under correction.
Ditto, Sheet No. 2 (in 2 sections)	6=1	2	Drawing in progress.
Dacca Division from Rennell's Atlas	1=24	1	Copied and supplied to the Collector of Faridpur.
Triangulation Charts of Gujrat Survey.			
Half Degree Sheets Nos. 1, 7, 8 and 9	1=2	4	Fair maps corrected and sent to press. Proof under corrections.
Index Maps.			
For Administration Report .	various.	6	Drawn and sent to press.
Ditto ditto .	„	17	Corrected to 1895, and sent to press.
Tracings prepared.			
Tracings of sheets . . .	„	48	
Village plans	„	41	
Maps coloured.			
Maps on various scales . .	„	236	For Surveyor-General's Office.

DRAWING OFFICE, CALCUTTA.

SECTION II—*concluded.*

Statement of work—concluded.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Bankura, Seasons 1889-93.	
Killa Kanika „ 1888—89.	
District Prome „ 1889—91.	
Traverse data, etc., supplied.	
Traverses of District Balaghat along District Raipur .	For No. 9 Party.
„ „ Hoshangabad along Betul . .	Ditto ditto.
„ of Balaghat Forests	For Superintendent, Forest Surveys.
„ of District Nagpur with connection from origin of survey.	Ditto ditto.
Traverses of District Nagpur Forests (15 pages) .	Ditto ditto.
„ of Chindwara Forests (7 pages) . .	Ditto ditto.
„ of District Gorakhpur along District Champaran.	For Nos. 4 and 5 Parties.
Traverses of Main Circuit No. 1, District Balasore .	For Orissa detachment.
„ of District Pooree (7 pages) . . .	Ditto ditto.
„ of Killa Banki (11 pages) . . .	Ditto ditto.
„ of District Prome	For Deputy Commissioner.
„ of District Hanthawaddy along unsurveyed portion.	For No. 20 Party.
Traverses of disputed boundary between Districts Monghyr and Sonthal Parganas	For Nos. 2 and 8 Parties.
Traverses of Kamrup and Darrang	For Director, Land Records, Assam.
Rectangular co-ordinates of pillars along Nepal and Kheri boundary.	For Superintendent, Forest Surveys.
Field area statement (7 pages)	For Garhwal Detachment.
Triangulation data of Hyderabad, Minor Series . .	For No. 12 Party.
„ „ of District Faridpur . . .	For Collector.
Values of G. T. S. bench marks in Sitapur and Fyzabad.	For Executive Engineer, Military Works.
Village Traverses supplied, 98 pages . . .	For public officers.
Miscellaneous.	
Calculated areas of 28 Tributary States of Chota Nagpur and Orissa; also of 7 sheets Bengal; 2 sheets Bombay; 2 sheets Central India Agency; 4 sheets North-Western Provinces and 1 sheet Burma; also area of Calcutta City from 479 field sections on 50 feet=1 inch maps; area of Buxa Forest, Jalpaiguri; of Government lands in Kugang Forests. Revised the areas of Districts Darjeeling and Dera Ghazi Khan; deduced mean magnetic variations of Districts Kamrup, Darang, Sibsagar, Lakhimpur, Srinagar Estate, Thongwa and Rampur State. Computed one traverse circuit of a group of Nadia Villages and plotted the same on 4-inch scale for a congregated village map; also of another group of villages for the Collector of Moorshedabad. Computed and plotted disputed boundary between Chukye and Punasi Estates in Districts Monghyr and Sonthal Parganas. Calculated A and L of Revenue Survey points of District Jubbulpore and Gujranwala; and calculated rectangular co-ordinates of certain stations in Rampur State and Calcutta City for projection. Examined two tables for converting acres into bighas, etc., and *vice versâ* of District Muzaffarpur. Prepared statements for Bengal as well as General Report. Checked annual statements received from Executive Officers.	

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1895.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS RECEIVED.			MAPS PUBLISHED.				
	Up to 30th September 1894.	Added during past 12 months.	Total up to 30th September 1895.	Up to 30th September 1894.	By Surveyor General's Office during past 12 months.	Total to 30th September 1895.	Remaining to be published.	
North-Western Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601	...	1,601	1,601	...	1,601	...	(*a*) These figures are liable to alteration until publication has been completed.
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571	...	5,571	5,571	...	5,571	...	
Benares	2,052	...	2,052	2,052	...	2,052	...	
Bijnor	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	701	...	701	...	
Fyzabad	14	...	14	14	...	14	...	
Ghazipur	4,021	...	4,021	4,021	...	4,021	...	
Gorakhpur	8,615	...	8,615	8,615	...	8,615	...	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	(*b*) Exclusive of 71 sheets reprinted.
Jaunpur	3,583	...	3,583	3,583	...	3,583	...	
Jhansi	1,661	...	1,661	1,656	5	1,661 (*b*)	...	
Kumaon (Bhabar)	332	...	332	332	...	332	...	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	(*c*) Exclusive of 23 sheets reprinted.
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,794	...	3,794	3,794	...	3,794	...	
Rampur State	1,356	...	1,356	1,356	...	1,356	...	
Tarai	862	...	862	862	...	862	...	
TOTALS	49,990	...	49,990	49,985	5	49,990	...	
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Amherst	2,050	1,341	3,391 (*d*)	1,406	1,737	3,143	248	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Kyaukse	801	...	801	801	...	801	...	
Mandalay	771	...	771	771	...	771	...	
Meiktila	699	...	699 (*d*)	164	531	695	4	
Mergui	771	...	771	698	373	1,071	...	
Prome	300	399	1,071	847	...	847 (*d*)	...	(*d*) Exclusive of 1 sheet reprinted.
Rangoon Town and Index	954	117	847	...	20	20	1,606	
Sagaing	847	...	20	28	652	680	...	
Tavoy	...	20	2,286 (*d*)	758	5	763	...	
Tharrawaddy	1,403	883	763	1,363	...	1,363	...	
Thaton	763	...	1,363	...	...	...	85	
Thongwa	1,363	...	85 (*d*)	3,749	...	3,749	...	
TOTALS	...	85	3,749	22,799	3,318	26,117	1,943	
	3,749	...	28,060					
	25,215	2,845						
Bengal.								
Muzaffarpur	1	...	1	1	...	1	...	
Patna and Gaya	3,054	...	3,054	3,054	...	3,054	...	
Puri (Khurda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
TOTALS	12,544	...	12,544	12,544	...	12,544	...	
Assam.								
Darrang	1,074	...	1,074	1,060	14	1,074 (*c*)	...	
Kamrup	2,218	...	2,218	2,209	1	2,210	8	
Lakhimpur	346	...	346	346	...	346	...	
Nowgong	1,277	...	1,277	1,277	...	1,277	...	
Sibsagar	2,050	...	2,050	2,042	...	2,042	8	
Sylhet	213	...	213	168	...	168	45	
Sylhet (Jaintia)	109	542	651 (*a*)	8	643	651	...	
TOTALS	7,287	542	7,829	7,110	658	7,768	61	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTALS	43	...	43	43	...	43	...	
GRAND TOTALS	95,079	3,387	98,466	92,481	3,981	96,462	2,004	

Abstract of work performed during 1894-95.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for Photo-zincography.	Traced and examined for Zincography.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	
North-Western Provinces	...	...	76	...	Scale 16 inches=1 mile.
Burma	4,129	761	3,371	...	
Assam	376	168	668	...	
TOTALS	4,495	929	4,115	...	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1894-95.

TITLE OF MAP.	Number of Sheets.	Outline.	Number of letters.	Hills, and Ornament.	REMARKS.
		Sq. ins.		Sq. ins.	
ENGRAVING.					
Indian Atlas.					
Scale, 1 inch = 4 miles.					
Quarter sheets, new, completed .	7	64	10,320	187	
Ditto „ in progress .	31	975	24,459	299	
Ditto „ projected .	9	...	1,862	...	
Additions and corrections to published quarter sheets . .	42	313	25,920	60	
Ditto ditto full sheets	21	286	31,322	235	
General Maps	15	426	30,206	4	
Provincial Maps.					
On scale 1 inch = 16 miles . .	11	573	58,447	13	
On various scales for Administration Reports	9	41	6,068	5	
District Maps.					
On various scales for Administration Reports	49	541	37,561	156	
Plans and Charts . . .	10	263	44,656	1,398	
Index Maps	3	6	11,472	...	
Miscellaneous subjects . .	25	...	26,219	...	
TOTAL .	232	3,488	308,512	2,357	

COPPER-PLATE PRINTING.

Impressions taken	24,795
Proofs pulled	400
Transfers pulled	359
TOTAL . .	25,554

STEEL FACING.

Double Elephant plates, steel faced	34
Ditto „ removed	31
Quarter sheets „ faced	61
Ditto „ removed	37
Miscellaneous plates „ faced	51
Ditto „ removed	23
TOTAL . .	237

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of Colonel J. Waterhouse, S.C., Assistant Surveyor-General, Season 1894-95.

OUTTURN — Owing to a further falling-off in the demands upon the office, the work generally shows a decrease from last year, but is still well up to the average. Abstracts of the work done, both departmental and extra-departmental, are given in the statements appended.

ORIGINAL SUBJECTS.—The number of original subjects under reproduction during the year has been only 5,908, or 954 less than last year. The decrease is principally in the departmental and cadastral maps, the extra-departmental work showing an increase. 510 subjects have been lithographed, 56 being departmental and 454 extra-departmental, against 538 (82 departmental and 456 extra-departmental) of last year. The remaining 5,398 were reproduced by various photographic processes or by zincography, and comprise 737 departmental, 3,859 cadastral and 802 extra-departmental.

The actual number of maps, etc., received during the year was 5,008, of which 835 were departmental, 2,667 cadastral and 1,506 extra-departmental, while the number completed and despatched was 6,360, of which 973 were departmental, 4,048 cadastral and 1,339 extra-departmental.

LITHOGRAPHIC DRAWING SECTION.—The total number of new drawings or additions etc., made to maps on stone, taken up and completed during the year, was 472, of which 41 were departmental and 431 extra-departmental. Last year 566 subjects were completed, of which 67 were departmental and 499 extra-departmental. The section remained under the charge of Mr. H. L. Lepage during the year, except for 3 months when he was absent on privilege leave. Munshi Sobhan Buksh, Examiner, retired during the year on superannuation pension after a service of about 41 years. He was a steady hard-working man and his loss is much felt in the office.

LITHOGRAPHIC PRINTING SECTION.—The number of subjects printed from stone was 476, or 40 more than last year; of these 39 were departmental and 437 extra-departmental, against 55 departmental and 381 extra-departmental of last year. The number of pulls from stone was 534,502, of which 93,305 were departmental and 441,195 extra-departmental, while the number of copies was 527,596, of which 106,352 were departmental and 421,244 extra-departmental

The machinery has not worked so steadily as in former years. One of the pistons of the engine broke and a new one had to be made by Messrs. Burn & Co., which took about a fortnight to complete, during which time the machinery could not be worked. The Worthington pump attached to the boiler also got out of order and was repaired by Messrs. Marshall & Co. In other respects the machines have worked well and steadily though there has been a falling-off in the amount of work for them. The section was under charge of Mr. E. A. LeFranc throughout the year. On return from furlough Mr. Deas resumed charge of the second large machine. The native machine-printers have made good progress during the year.

ZINC-PRINTING SECTION.—The number of zinc plates printed during the year was 1,242, of which 598 were departmental and 644 extra-departmental. The number of pulls was 213,164 (97,159 departmental and 116,005 extra-departmental) and of complete copies 255,446 (105,447 departmental and 149,999 extra-departmental). Last year the number of plates printed was 1,265 (730 departmental and 535 extra-departmental), pulls 266,795 (127,695 departmental and 139,100 extra-departmental) and copies 355,009 (139,903 departmental and 215,106 extra-departmental). These figures show a general decrease in printed outturn, both departmental and extra-departmental, although the number of zinc plates printed for extra-departmental work was 109 more than last year.

CADASTRAL ZINC-PRINTING SECTION.—Four thousand and two plates of cadastral maps of North-Western Provinces, Burma and Assam were printed off, the number of pulls being 146,620, and of copies of complete villages 138,800, against 4,716 plates, 168,772 pulls and 159,142 complete copies of the previous year. The decrease in the number of plates printed is again chiefly due to the number of plates, 714 only, of the North-Western Provinces and Assam printed off. It is chiefly, however, due to the fact that fewer sheets came in for reproduction, and it was even found necessary to stop the work of transfer tracings for zincography owing to the paucity of sheets in hand. Mr. G. A. LeFranc had charge of this work till the 4th May, when he was transferred to the Dehra Dun office and Mr. P. Michael was put in charge. Mr. J. DeSilva was appointed an apprentice in this section and has learnt his work very well.

TYPE-PRINTING SECTION.—The number of items set up was 11,679, of pulls 1,291,041 and of copies 652,175, against 10,785 items, 1,564,453 pulls and 820,605 copies of last year, showing an increase in the number of items set up but a decrease in the number of pulls and copies, which is to some extent due to the stoppage of the machinery. The section has been under charge of Mr. de Pyvah and with the additional establishment noticed last year the work has gone on satisfactorily.

NEGATIVE SECTION.—The total number of negatives taken during the year in the Normal and Cadastral Sections, including 45 reversed negatives and 75 transparencies required for the heliogravure process, was 4,779: of these 1,022 were of departmental maps, etc., 2,873 cadastral and 884 extra-departmental. Last year the numbers were 1,339

departmental, 3,418 cadastral and 796 extra-departmental, showing a decrease of 317 departmental, 545 cadastral and an increase of 88 extra-departmental, or a total decrease of 774 negatives, due to the smaller amount of work coming in. Mr. H. Haward returned from furlough on the 9th January and resumed charge of the section. There have been no changes in the processes.

PHOTO-TRANSFER PRINTING SECTION.—The number of photo-transfer prints prepared was 4,624, of which 981 were departmental, 2,955 cadastral and 688 extra-departmental, against 1,523 departmental, 3,506 cadastral and 746 extra-departmental of last year, showing decreases of 542 departmental, 611 cadastral and 58 extra-departmental, or in all 1,211. The processes have remained unchanged. Mr. Harrold resumed charge of the section from the 9th January, and Mr. R. George was appointed to officiate as Storekeeper during the absence of Mr. W. Moore, on furlough, from 1st April.

SILVER PRINTING SECTION.—The number of silver prints made during the year was 652 against 1,355, showing a decrease of 703 which is chiefly extra-departmental. The demand for silver prints is always very uncertain and fluctuating. The number of blue prints shows a considerable increase, the number done during the year being 3,168, against 2,648 of the previous year. The increase, amounting to 520, is chiefly in departmental work, but also partly in extra-departmental work.

A new process of silver printing on plain paper has been tried with very good results. It was described by Mr. G. H. Moss in the *British Journal of Photography* for 9th August 1895 and is briefly as follows:—

Suitable paper, either Whatman's drawing paper, smooth or rough surface, or ordinary photographic Rives paper, is soaked for 3 minutes in a bath of

Sodium chloride (crystals) not common table salt	150 parts.
Ammonium Chloride	100 „
Potassium Bichromate	4 to 6 „
Water to	8,750 „

When dry sensitise on—

Silver Nitrate	400 parts.
Citric Acid	150 „
Water	4,375 „

The paper is floated for about 2 minutes, the surface becoming a light primrose, and dried.

The printing should be a little deeper than desired. The prints are toned in any ordinary toning bath about half the strength used for gelatino-chloride printing-out paper, rinsed in several waters and fixed in a 10 per cent. solution of hyposulphite soda, 10 minutes for Rives paper and 20 minutes for Whatman's drawing paper and other rough heavy papers. Then well washed for about 2 hours in running water.

The peculiarity of the paper is that there is no gelatine or other colloid material used in its preparation beyond the natural sizing, and yet with good and suitable negatives the print is well on the surface and full of detail, even in the deepest shadows. The amount of bichromate in the salting solution may be varied, more being used for thin negatives and less for dense hard ones. The paper when sensitised can be kept in good condition, at any rate, for several weeks, and this is a very great convenience as it enables a small stock of the paper to be kept in readiness for small or urgent requisitions.

The absence of gelatine or other colloid material is of great importance to the permanency of the prints, and with due care in fixing and washing they should be far more permanent than ordinary silver prints on albumenised paper. Another great advantage of the prints is that they remain flat and do not curl up as albumenised or gelatine prints do.

Trials were also made of another simple printing process patented by Messrs. Arndt and Troost, an abstract of which was given in the *British Journal of Photography* for August 23rd, 1895. The formula for the sensitising bath is as follows:—

Water	1,000 parts.
Citrate of Iron and Ammonia	80 „
Silver Nitrate	12 „
Tartaric Acid	16 „
Gelatine	10 „

When the ingredients were added in the order as given above there was a slight precipitate. Paper was coated with the clear solution with a brush and when dry was of a light brown colour. It was found to be very sensitive and for a line subject about 5 minutes' exposure in sunlight is sufficient.

The prints are developed by simple immersion in tap water, but some difficulty was experienced in getting clear prints. Fixing with the ordinary solution of soda hyposulphite cleared the ground but reduced the prints very much. A solution of oxalic acid was also found of good effect in clearing the prints, though the ground was still slightly stained. A modification of the formula as follows:—

Water	1,250 parts.
Citrate of Iron and Ammonia	100 „
Silver Nitrate	10 „
Tartaric Acid	50 „

gave a better result when the prints were treated, after washing, with the oxalic acid solution, the ground being white and the lines of a pleasing chocolate colour.

The process was not found suitable for half-tone work but would answer very well for all line subjects and is far more rapid than the cyanotype process, while about as simple in procedure.

The work of the section has been carried on by Mr. C. J. Meade and the above experiments were made by him.

HELIOGRAVURE SECTION.—This section has been fully occupied during the year and the outturn has been about the same as last year, though slightly less in some items. The number of plates prepared by the photo-etching process was 85, or one less than last year. 49,675 prints were taken, giving a decrease of 1,003. The number of electrotypes was 7, against 18 of the previous year, owing to smaller demands from the Engraving office, and this item is always a fluctuating one. Six photo-blocks were prepared, or 2 more than last year.

A further trial has been made of the method of printing the hills by heliogravure on to a hand engraved map, which was described in the Annual Report for 1892-93. A specimen map of India produced in this way is given at page 107 of this report.

The method by which it was produced is the same as before, *i.e.*, the hills were drawn on glass with a black crayon and this drawing was used as a transparency from which the photo-etching was made. The difficulty in the method is to secure accurate registration of the different colour plates and it is absolutely necessary that the prints should be taken on dry paper. Ordinary lithographic or drawing paper used dry will not pick up the ink well, even with great pressure, and consequently give imperfect prints.

The specimen map of part of the Andaman Islands, given in the Annual Report for 1892-93, was printed dry on a paper known as 'Art' paper, which is specially prepared for collotype and 'process' printing and takes up ink very readily. The quality of the paper is, however, not quite suitable for printing maps, especially of a large size. Mr. Turner has, therefore, experimented with strong drawing and lithographic paper and has succeeded in finding a method by which perfect impressions can be pulled *dry* either from an engraved or photo-etched plate, and it should be very valuable not only for the heliogravure work, but also in pulling dry impressions from hand-engraved maps.

The method is described by Mr. Turner as follows :—

The paper (either drawing or litho.) is first damped and then left under pressure for an hour or two to thoroughly soften and expand the fibre of the paper. After this it is coated with the following preparation :—

Mountain Snow (baryta white)	6 lbs.
Water	30 ounces.

Mix and grind well together till it is of the consistency of a well-ground printing ink; then gradually add

Gelatine, soaked and dissolved in	1 ounce.
Water	30 ounces.

Stirring well until it forms a fine creamy solution. After being passed through a muslin strainer it is applied as evenly as possible to the surface of the damped paper with a sponge with which it is well rubbed into the paper. A flat camel-hair brush is then passed over the surface in all directions to more evenly distribute the preparation. The paper is then hung up to dry. The thin coating thus produced has not the unpleasant gloss of the ordinary 'Art' or surfaced enamel papers, and is almost imperceptible, while quite sufficient to pick up the ink and secure perfect impressions when used dry. The paper can also be folded and treated in every way as a non-surfaced paper.

There has been no variation during the year in the processes and formulæ ordinarily in use in this section. Some trials have, however, been made by Mr. Haward of the enameline process for preparing half-tone photo-blocks, which he learnt during his furlough and has since taken a great deal of trouble to work out and develop. As the process is a secret one the details cannot be published. Though undoubtedly capable of giving very good results it has not been found to answer very well here, owing to the difficulty of keeping in good order the liquid fish-glue, which forms one of the principal ingredients of the sensitising solution for the plates. It becomes acid and then gives rotten films which will not stand well after burning. This defect has also been experienced in Europe, but is of course worse here on account of the climate hastening the decomposition of the glue, and the difficulty of obtaining fresh supplies as required.

Apart from this uncertainty the process does not as yet show a sufficiently marked advantage over that given in the Annual Report for 1890-91 to warrant its definite adoption. The latter process is moreover more convenient in many ways and particularly so in not requiring a reversed negative. The accompanying plate of a reproduction of a water-colour drawing of Kila Drosh by Major Bythell, R.E., from a block prepared by Mr. Haward, is a fair specimen of the enameline process.

Besides working at the enameline process Mr. Haward has done a good deal of experimental work in taking negatives with the ruled screens suitable for the half-tone blocks, and the information he obtained in Europe about the working of these processes has proved useful. The half-tone block processes, however, require entirely special arrangements for working them at their best and are not found so adaptable for general purposes as the heliogravure process, in which the operations are not only very much simpler and more certain, but the plates admit of a great deal of working up to suit indifferent or faulty

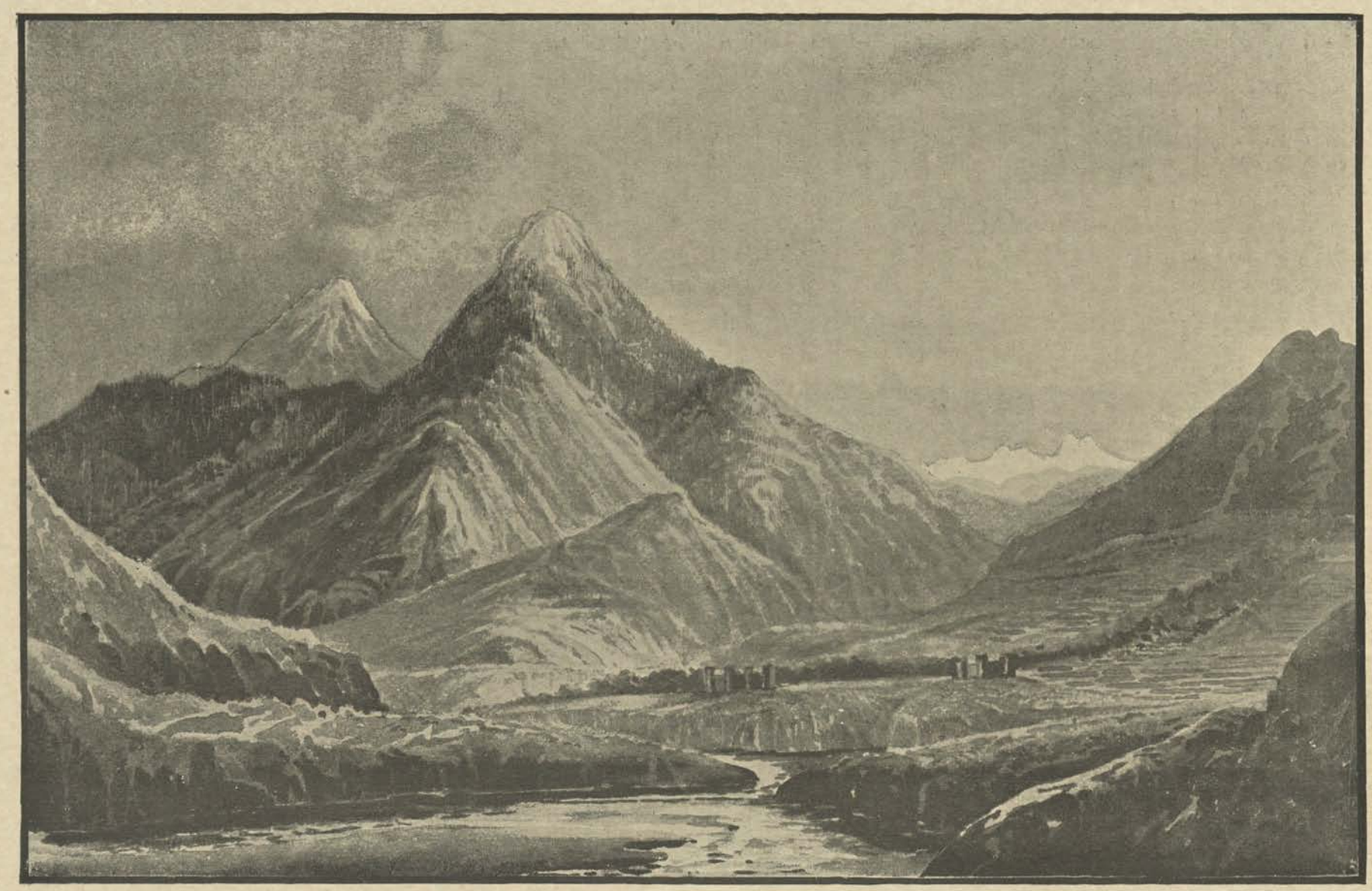


Photo.-Block (Enamelline). Survey of India Offices, Calcutta.

KILA DROSH, FROM THE NORTH.

From a drawing by Major W. J. Bythell, R.E.

negatives. The advantages of the block processes are the greater speed of printing and the convenience of printing the blocks with type, but the latter is to a great extent neutralised by the difficulty experienced in getting the blocks properly printed here. Experiments are, however, being made for surface printing from the creennigatives on to zinc or stone, which seem likely to give good results. On the whole the heliogravure process seems most suitable for the class of work that comes in to this office for reproduction.

EXPERIMENTAL AND PERSONAL WORK.—The sole superintendence of the working of the office in its many branches leaves me little spare time for regular experimental work in office hours, while I can no longer devote so much of my leisure time to it as formerly. I have, however, carried out some trials of a collodion emulsion process which seemed likely to be useful and had the advantage that the emulsion did not require precipitation and washing and therefore could be worked much more cheaply than the washed emulsion process described in the Annual Report for 1891-92. The results, though promising, were not found quite suitable for our requirements, nor were the plates nearly so sensitive as with the former process. I made a complete translation of a long article by Dr. J. M. Eder on the use of cross-line screens for half-tone process blocks, which was published in the "*Photographische Correspondenz*" and gives a great deal of valuable information on the subject. I also made a considerable number of observations with various forms of an electrical actinometer on the principle of the one described by Messrs. Rigollot and Gouy in the "*Annales de Chimie et de Physique*," Vol. XXII, 1891, in which a pair of copper plates, one of which has been oxidised over a Bunsen flame and the other unoxidised, is plunged into a very weak solution (1 : 1,000) of potassium iodide, chloride or bromide. The best results were obtained with the plates in a solution of potassium iodide, but the instrument generally does not appear to be sufficiently constant to be of practical use in photographic work. An actinometer which could be depended on to accurately and quickly register the comparative actinic power of the light in the exposing room on dull cloudy days would be very useful. With further experiment it seems probable that better results might be obtained

PHOTOGRAPHIC AND

Abstract of Departmental Work

Specification.	Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	*Number of Copies.*		
								Colored.	Uncolored.	Total.
Departmental Maps, Plans, etc.										
General Maps	9	4	4	2	24	8	2,680	...	1,455	1,455
Provincial Maps	35	38	54	24	30	11	6,330	650	2,930	3,580
District Maps	21	22	22	8	8	9	1,625	...	1,625	1,625
Plans of Cities and Cantonments	94	155	161	86	169	...	13,139	...	11,639	11,639
Standard Maps	319	406	391	137	155	4	23,587	...	23,437	23,437
Index Maps	51	68	88	85	83	5	44,420	37,572	5,200	42,772
Technical Charts	30	36	12	4	4	...	150	...	175	175
Miscellaneous Maps and Plans	219	283	249	63	121	18	18,810	1,410	31,606	33,016
Transfers and Proofs	...	...	...	...	...	...	2,224	...	...	...
Departmental Forms	15	...	...	...	4	17	77,500	...	94,100	94,100
Type Printings	...	...	...	...	...	...	...	...	...	...
Totals (Normal)	793	1,022	981	409	598	72	1,30,465	39,632	172,167	211,799
Cadastral Maps.										
North-Western Provinces—										
Photozincographs	73	73	71	76	76	...	491	...	491	491
Zincographs	...	...	...	...	...	...	...	...	...	...
Totals	73	73	71	76	76	...	491	...	491	491
Burma—										
Photozincographs	2,335	2,335	2,399	2,451	2,451	...	76,622	...	76,622	76,622
Zincographs	800	...	...	800	800	...	25,388	...	25,388	25,388
Totals	3,135	2,335	2,399	3,251	3,251	...	102,010	...	102,010	102,010
Assam—										
Photozincographs	465	465	484	489	489	...	26,398	...	26,398	26,398
Zincographs	186	...	...	186	186	...	9,901	...	9,901	9,901
Totals	651	465	484	675	675	...	36,299	...	36,299	36,299
Bengal—										
Photozincographs	...	...	1	...	...	...	...	...	...	...
Zincographs	...	...	...	...	...	...	...	...	...	...
Totals	...	...	1	...	...	...	...	...	...	...
Transfers and Proofs	...	...	...	...	...	...	7,820	...	...	...
Totals (Cadastral)	3,859	2,873	2,955	4,002	4,002	...	146,620	...	138,800	138,800
GRAND TOTALS (Normal and Cadastral)	4,652	3,895	3,936	4,411	4,600	72	337,085	39,632	310,967	350,599

LITHOGRAPHIC OFFICE.

done during the year 1894-95.

Type Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.		
									R a. p.	
...	...	...	...	...	...	...	...	...	2,325 3 9	
...	...	...	...	...	...	...	...	...	2,973 6 6	
...	...	...	...	...	...	...	...	...	3,451 0 9	
...	...	...	...	157	...	...	...	...	6,801 13 0	
...	...	...	...	1,793	...	...	...	...	15,154 10 9	
...	...	...	...	116	...	...	...	...	4,172 8 6	
...	...	...	...	75	...	...	...	...	485 13 3	
...	...	...	76	377	10	1,441	...	7	8,271 11 6	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	7,319 5 0	
11,679	1,291,041	652,175	...	...	...	...	...	...	20,902 3 0	
11,679	1,291,041	652,175	76	2,518	10	1,441	...	7	71,857 12 0	
...	...	...	...	...	...	...	...	...	806 3 3	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	806 3 3	
...	...	...	...	...	...	...	...	...	37,855 10 6	
...	...	...	...	...	...	...	...	...	6,980 4 0	
...	...	...	...	...	...	...	...	...	44,835 14 6	
...	...	...	...	...	...	...	...	...	10,512 4 9	
...	...	...	...	...	...	...	...	...	2,378 0 9	
...	...	...	...	...	...	...	...	...	12,890 5 6	
...	...	...	...	...	...	...	...	...	1 12 9	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	1 12 9	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	58,534 4 0	
11,679	1,291,041	652,175	76	2,518	10	1,441	...	7	130,392 0 0	

PHOTOGRAPHIC AND

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and: Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.
Adjutant General in India	4	...	...	...	1	3	1,720
Agent and Chief Engineer, Assam-Bengal Railway	50	42	42	22	23	...	2,300
Agent and Chief Engineer, Bombay, Baroda and Central India Railway	6	7	7	5	6	2	2,640
Agent and Chief Engineer, Bengal and North-Western Railway	5	5	5	3	3	...	300
Agent to Governor-General, Central India and Rajputana	1	...	...	...	1	3	260
Amritsar Municipality	8	...	...	...	8	...	800
Archæological Surveyor, North-Western Provinces and Oudh	18	18	...	...	...	...	...
Architectural Surveyor, North-Western Provinces and Oudh	232	155	84	24	24	10	19,800
Assistant Adjutant General, Mandalay District	...	...	...	...	1	...	10
Asiatic Society, Bengal	14	25	3	2	2	3	2,636
Bangalore Municipality	4	10	10	4	4	...	5,000
Board of Revenue, Bengal	5	...	...	...	3	20	1,820
„ North-Western Provinces and Oudh	16	26	34	12	12	...	3,000
Brigadier General Commanding Hyderabad Contingent	15	4	4	1	10	2	2,400
Calcutta Municipality	17	26	23	30	32	2	7,235
Chief Commissioner, Assam	1	...	...	...	...	1	4,000
„ Burma	...	...	...	...	8	...	224
„ Central Provinces	...	...	...	...	...	1	360
Chief Engineer, Bengal, Public Works Department	24	42	39	18	21	19	8,708
„ East Indian Railway	3	...	...	...	1	...	50
„ Irrigation Works, Punjab	22	31	30	17	22	2	10,060
„ Public Works Department, Punjab	18	24	24	13	16	3	2,600
Colonial Secretary, Straits Settlements	1	2	2	1	9	...	2,718
Collector of Customs, Calcutta	5	...	...	...	3	9	6,000
Commandant, Sirdar Rissala, Jodhpur	...	...	...	2	4	...	400
Commissioner of Assam	...	...	...	...	...	...	...
„ Northern Division, Mandalay	...	...	...	...	6	...	210
„ of Excise, Bengal	4	...	...	...	...	4	1,800
„ „ Punjab	7	...	...	...	8	...	1,720
„ of Police, Calcutta	...	...	...	...	...	2	2,128
„ of Salt, Abkari, etc., Madras	...	...	...	...	...	1	370
„ of Settlement and Agriculture, Central Provinces	...	...	...	1	2	...	1,305
Dacca Municipality	...	...	...	...	1	...	50
Deputy Adjutant General, Bengal	2	4	4	1	...	1	50
„ „ Punjab Command	1	2	2	1	...	...	...
„ Assistant Adjutant General, Meerut Division	...	...	...	...	1	...	70
„ „ „ „ Peshawar District	2	8	8	3	5	...	400
„ „ „ „ Rohilkhund District	1	...	...	...	...	1	100
„ „ „ „ Rawalpindi District	1	2	2	2	...	...	...
„ „ Quarter Master General, Intelligence Branch, Burma	7	18	18	9	12	...	1,438
Deputy Commissioner, Gurgaon	15	...	...	...	23	...	910
Director General of Military Works	19	39	39	13	21	...	852
„ „ Post Offices, Bengal	6	...	...	...	...	9	280
„ „ Telegraphs	21	...	...	...	2	24	14,502
Director, Geological Survey of India	20	12	2	...	1	18	7,655
„ Land Records and Agriculture, Assam	...	...	...	...	...	...	80
„ „ „ Bengal	8	...	...	...	19	15	14,125
„ „ „ Punjab	3	7	7	3	3	...	300
„ Botanical Survey of India	1	...	...	...	...	1	300
„ Military Education in India	6	8	8	6	12	...	6,000
„ Public Instruction, Bengal	4	...	...	...	4	...	2,392
Engineer-in-Chief, Assam-Burma Railway	13	22	22	14	19	...	1,520
„ Northern-Bengal-Assam Connection Railway	1	...	...	...	2	...	560
„ Saugor-Kutni Railway	2	...	...	...	...	4	240
„ Umerkot-Pachbadra Railway	1	...	...	...	...	1	50
Examiner, Telegraph Accounts	2	...	...	...	...	1	200
Financial Commissioner, Punjab	2	...	...	...	...	4	950
General Officer Commanding Lahore District	1	4	4	1	1	...	150
„ „ „ Meerut District	1	2	2	1	1	...	50
„ „ „ Oudh District	3	10	10	3	3	...	900
„ „ „ Sirhind District	1	2	2	1	1	...	100
Government of India, Revenue and Agricultural Department	31	22	12	9	13	35	103,634
Carried over	655	579	449	222	374	201	250,432

LITHOGRAPHIC OFFICE.

Departments, during the year 1894-95.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.		
Number of copies.											
Coloured.	Uncoloured.	Total.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.	₹	a.	p.
...	1,720	1,720	...	...	...	...	...	..	225	13	0
...	4,500	4,500	...	...	...	...	...	...	921	3	0
1,050	600	1,650	...	...	...	...	...	...	936	10	0
...	500	500	...	...	...	...	...	...	147	6	9
70	50	120	...	...	...	...	...	...	184	11	6
...	100	100	...	...	...	...	...	...	655	11	0
...	...	...	...	54	...	550	...	...	210	14	3
...	69,250	69,250	18	399	6	8,457	...	...	6,318	3	9
...	20	20	...	...	...	...	...	...	6	10	0
...	2,636	2,636	...	12	9	5,409	...	...	1,301	5	9
...	3,000	3,000	...	...	...	...	...	...	815	9	3
620	880	1,500	...	...	...	...	...	...	342	14	0
...	3,000	3,000	...	140	...	...	...	...	1,282	15	9
...	3,000	3,000	...	...	...	...	...	...	713	3	9
2,105	3,530	5,635	...	3	...	...	...	...	1,378	14	3
...	4,000	4,000	...	...	...	...	...	...	136	3	0
...	224	224	...	...	...	...	...	...	81	0	0
...	360	360	62	...	...	...	...	...	80	15	0
1,619	5,130	6,749	...	...	...	...	...	...	1,759	10	9
...	50	50	...	...	...	...	...	...	231	2	0
250	12,310	12,560	...	...	...	...	...	...	1,502	7	3
...	3,100	3,100	...	...	...	...	...	...	1,241	15	9
...	2,718	2,718	...	...	...	...	...	...	531	6	0
2,500	...	2,500	...	...	...	...	...	...	484	12	0
...	200	200	...	...	...	...	...	...	91	1	9
...	...	...	...	...	...	...	...	...	7	5	0
...	210	210	...	...	...	...	...	...	41	13	6
1,800	...	1,800	...	...	...	...	...	...	231	9	0
1,505	...	1,505	...	...	...	...	...	...	187	10	0
1,064	...	1,064	...	...	...	...	...	...	134	5	0
...	370	370	...	...	...	...	...	...	56	4	0
...	1,305	1,305	...	...	...	...	...	...	198	4	6
...	50	50	...	...	...	...	...	...	6	9	6
...	50	50	...	...	...	...	...	...	101	13	6
...	...	...	...	...	...	...	...	...	32	1	6
...	70	70	...	...	...	...	...	...	21	1	9
...	250	250	...	...	...	...	...	...	193	1	0
...	100	100	...	...	...	...	...	...	173	4	0
...	...	...	...	...	...	...	...	...	40	12	9
...	1,506	1,506	...	...	...	...	...	...	632	6	3
...	910	910	...	...	...	...	...	...	326	9	0
...	1,252	1,252	..	...	...	...	...	...	802	3	0
94	140	234	...	...	...	...	...	...	39	7	0
...	14,622	14,622	...	...	...	...	...	...	3,977	1	0
2,170	2,120	4,290	...	...	3	803	...	...	1,441	5	6
...	80	80	..	...	...	...	...	...	1,362	8	0
4,250	3,500	7,750	...	...	...	...	...	...	1,365	9	0
...	300	300	...	...	...	...	...	...	203	11	9
...	300	300	...	...	...	...	...	...	96	3	0
1,200	1,800	3,000	...	...	...	...	...	...	844	6	0
2,392	...	2,392	...	...	...	...	...	...	161	13	0
...	1,920	1,920	...	...	...	...	...	...	759	12	0
280	...	280	...	...	...	...	...	...	56	12	0
60	60	120	...	...	...	...	...	...	83	9	6
...	50	50	...	...	...	...	...	...	21	2	0
...	400	400	...	...	...	...	...	...	35	1	0
245	460	705	...	...	...	...	...	...	372	3	9
...	150	150	...	...	...	...	...	...	95	8	0
...	50	50	...	...	...	...	...	...	49	7	9
...	900	900	...	...	...	...	...	...	358	13	0
...	100	100	...	...	...	...	...	...	62	8	9
32,246	18,932	51,178	...	24	11	12,111	...	...	8,574	3	0
55,520	172,835	228,355	80	632	29	27,330	...	...	44,730	13	9

Statement of Work done for other

Departments, etc.	Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and				
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc plates printed.	Stones.	Pulls.
Brought forward	655	579	449	222	374	201	250,432
Government of India, Finance and Commerce Department	2	...	...	...	...	1	50
„ „ Foreign Department	34	18	18	8	30	8	1,759
„ „ Home Department	2	...	...	...	...	1	45
„ „ Military Department	6	3	3	3	5	...	300
„ „ Public Works Department	74	61	53	33	39	14	16,330
„ Bengal, Revenue and General Department	23	2	2	3	11	8	30,475
„ „ Financial Department	1	1	...	...	...	1	1,686
„ „ Judicial Political Department	1	...	...	...	5	...	2,050
„ „ Marine Department	3	...	...	...	1	1	440
„ „ Public Works Department, Irrigation Branch	27	30	30	16	10	4	805
Government of North-Western Provinces and Oudh, Public Works Department	14	10	10	6	10	3	5,480
Government of Punjab, Public Works Department	...	...	...	...	...	...	200
„ „ Revenue Department	1	...	...	...	...	6	2,905
„ Epigraphist, Madras	12	8	6	3	3	...	2,085
Imperial Institute, London	...	...	...	...	1	...	3,016
Indian Medical Congress	21	13	1	...	...	5	2,500
„ Museum	101	33	...	...	...	...	...
Inspector General of Artillery in India	12	1	...	...	...	6	1,560
„ „ Civil Veterinary Department	2	...	...	...	1	2	640
„ „ Imperial Service Troops	2	...	...	...	...	1	20
„ „ Jails, Bengal	2	...	...	...	2	1	100
„ „ of Police, Bengal	4	...	...	...	4	...	1,760
„ „ „ Burma	...	...	...	...	6	...	12
Manager, Eastern Bengal State Railway	8	1	1	1	4	1	2,250
Meteorological Reporter, Bengal	3	...	...	...	6	...	18,640
„ „ India	62	...	...	...	12	22	97,792
Military Secretary to His Excellency the Viceroy	1	2	2	1	2	...	43
Photographic Society of India	6	4	...	...	...	...	...
Port Commissioners, Calcutta	2	6	6	2	3	...	210
Port Officer and Registrar of Wrecks, Calcutta	...	...	...	...	...	4	560
Post Master General, Bengal	2	1	...	...	...	...	...
„ „ North-Western Provinces and Oudh	...	...	...	3	6	...	1,200
„ „ Rajputana	2	...	...	...	...	...	...
Principal, Dacca College	...	...	...	...	...	...	140
Private Secretary to His Excellency the Viceroy	2	2	2	...	...	...	...
„ „ to His Honour the Lieutenant-Governor, North-Western Provinces and Oudh	1	...	...	...	1	...	40
Protector of Emigrants, Calcutta	...	...	...	...	...	4	8
Quarter Master General in India	11	22	22	10	23	1	2,725
Reporter on Economic Products, India	3	...	...	...	...	4	4,512
Royal Society, London	...	...	...	...	...	1	950
„ Survey Department, Siam	13	41	41	12	12	...	1,550
Sanitary Commissioner, Assam	1	...	...	...	...	1	300
„ „ Bengal	6	...	...	...	4	5	6,300
„ „ Central Provinces	...	...	...	...	1	...	275
„ „ Hyderabad Assigned Districts	1	...	...	...	...	4	800
„ „ India	1	2	...	...	...	3	2,400
Sanitary Engineer, Bengal	3	5	5	2	2	...	50
Sarun Municipality	1	...	...	...	...	...	...
Secretary for Berar to the Resident at Hyderabad	10	...	...	1	...	3	720
„ Lady Dufferin's Fund	1	1	...	...	...	2	3,000
„ His Highness the Nizam's Government	16	16	16	6	...	...	...
Settlement Officer, Kanika	...	...	1	1	1	...	135
Superintendent, Government Press, North-Western Provinces and Oudh	1	...	...	...	...	3	1,110
Superintendent, Government Printing, India	53	8	8	5	24	24	59,673
„ „ „ Burma	...	...	...	...	...	...	...
„ Stationery, Calcutta	..	...	...	..	4	3	6,675
„ Emigration „	2	...	...	...	...	2	4
„ Presidency Jail „	2	...	...	...	...	...	...
„ Royal Botanical Gardens, Sibpur	1	2	...	...	...	...	...
„ Government Records	1	1	1	1	1	...	1,000
Traffic Superintendent, Bengal and North-Western Railways	1	...	...	...	...	2	6,000
War Office, London	...	...	...	...	2	...	220
Special Work done for Trade and Private Individuals	40	11	11	9	34	9	13,269
Total	1,256	884	688	348	644	361	557,201

LITHOGRAPHIC OFFICE.

Departments, during the year 1894-95—contd.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.		
Number of copies.											
Coloured.	Uncoloured.	Total.	Silver Prints.	Blue Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	₹	a.	p.
55,520	172,835	228,355	80	632	29	27,330	...	...	44,730	13	9
...	100	100	...	...	...	...	...	...	55	1	0
138	1,835	1,973	...	...	...	...	...	...	2,073	15	0
...	90	90	...	...	...	...	...	...	35	14	0
...	380	380	...	...	...	...	...	...	257	8	0
1,890	18,250	20,140	...	...	8	1,010	...	...	4,097	4	9
19,662	4,846	24,508	...	...	...	...	...	...	1,469	12	9
686	1,000	1,686	2	...	...	...	...	...	93	5	9
650	100	750	...	...	...	...	...	...	212	15	6
...	660	660	...	...	...	...	...	...	103	10	0
50	1,105	1,155	...	...	...	...	...	...	733	0	9
1,500	3,440	4,940	...	...	...	...	...	...	1,259	8	9
...	200	200	...	...	...	...	...	...	13	14	0
...	1,555	1,555	...	...	...	...	...	...	708	7	0
...	2,085	2,085	...	...	2	1,402	...	...	591	5	6
...	3,016	3,016	...	...	...	...	...	...	247	4	9
...	3,500	3,500	4	8	5	2,605	...	...	1,092	3	6
...	...	...	449	5	23	7,873	...	...	2,663	11	6
...	2,960	2,960	...	1	...	...	...	...	218	11	6
...	640	640	...	...	...	...	...	...	206	6	0
...	40	40	...	...	...	...	...	...	54	6	0
...	100	100	...	...	...	...	...	...	66	6	0
1,760	...	1,760	...	...	...	...	...	...	151	8	0
...	12	12	...	...	...	...	...	...	21	9	6
1,000	400	1,400	...	...	...	...	...	...	189	11	6
16	18,600	18,616	...	...	...	...	...	...	328	12	0
7,050	113,582	120,632	...	...	...	...	...	...	3,387	15	0
...	43	43	...	...	...	...	...	...	46	5	0
...	...	...	4	...	3	5,607	4	...	360	0	0
...	210	210	...	...	...	...	...	...	170	8	3
140	140	280	...	...	...	...	...	...	144	6	0
...	...	...	...	...	2	602	...	...	48	0	0
...	1,200	1,200	...	...	...	...	...	...	283	7	9
...	...	...	...	...	...	...	...	...	103	3	0
...	140	140	...	...	...	...	...	...	35	0	0
...	...	...	...	...	...	...	...	...	23	6	6
...	40	40	...	...	...	...	...	...	125	11	0
4	...	4	...	...	...	...	...	...	81	9	0
...	2,430	2,430	...	...	...	...	...	...	915	0	9
...	6,812	6,812	...	...	...	...	...	...	234	12	0
...	950	950	...	...	...	...	...	...	197	9	0
...	1,550	1,550	...	...	...	...	...	...	1,097	5	6
...	300	300	...	...	...	...	...	...	21	13	0
3,500	700	4,200	...	...	...	...	...	...	387	2	0
...	275	275	...	...	...	...	...	...	31	15	3
200	...	200	...	...	...	...	...	...	48	11	0
800	800	1,600	...	...	1	402	...	...	326	15	6
...	50	50	...	...	...	...	...	...	67	0	6
...	...	...	...	...	...	...	...	...	99	0	0
...	2,400	2,400	...	...	...	...	...	...	211	11	3
1,500	...	1,500	2	...	1	1,502	...	...	345	4	9
...	...	...	...	...	...	...	...	...	219	0	0
...	135	135	...	...	...	...	...	...	37	4	0
370	370	740	...	...	...	...	...	...	125	12	0
4,408	72,950	77,358	...	...	...	...	...	...	2,554	5	9
...	...	...	26	...	...	...	...	...	13	10	6
...	6,675	6,675	...	...	...	...	...	...	342	14	6
4	...	4	...	...	...	...	...	...	24	9	0
...	...	...	9	...	...	...	2	...	22	15	3
...	...	...	...	...	1	501	...	...	100	12	9
...	1,000	1,000	...	...	...	...	...	...	94	8	0
3,000	...	3,000	...	...	...	...	...	...	225	15	0
...	220	220	...	...	...	...	...	...	51	10	3
1,040	15,634	16,674	...	4	...	...	...	...	2,220	7	9
104,888	466,355	571,243	576	650	75	48,234	6	...	76,534	11	0

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Details of Issues to and Receipts from Provinces and Departments during the financial year 1894-95.

PROVINCES AND DEPARTMENTS.	VALUE OF			
	Receipts.	Issues.	Debits.	Credits.
	R	R	R	R
Assam	...	7,786	7,786	...
Bengal Civil	8,775	22,662	13,887	...
Bengal Military, East	400	2,532	2,132	...
„ „ West	1,396	7,309	5,913	...
Bombay Civil	5,560	23,390	17,830	...
„ Military	2,927	2,291	...	636
Burma	9,689	12,631	2,942	...
Central Provinces	204	6,107	5,903	...
Foreign States, Berar	...	279	279	...
Forests	...	6,883	6,883	...
Geological Survey and Museums	376	291	...	85
Guaranteed Railways and East Indian Railway	...	639	639	...
Land Revenue	...	104	104	...
Madras Civil	2,469	5,499	3,030	...
„ Military	303	1,564	1,261	...
Marine	59	1,078	1,019	...
Meteorological Department	425	2,358	1,933	...
Mint	123	...	...	123
North-Western Provinces and Oudh	904	25,536	24,632	...
North-Western State Railway, Public Works Department	188	6,023	5,835	...
Public Works Department, Military Works	3,050	4,017	967	...
Public Works Department, Baluchistan, Railway Branch	2,939	165	...	2,774
Political	...	323	323	...
Punjab	3,212	9,517	6,305	...
Rajputana Public Works Department and Central India	349	184	...	165
Public Works Department, Indian Midland Railway	...	382	382	...
Special Political—				
Waziristan Delimitation Commission	...	544	544	...
Asmar Boundary Commission	...	135	135	...
Survey Department (Field Parties)	30,273	70,291	40,018	...
Ditto ditto, Head-Quarters Offices, Calcutta and Dehra Dun	2,234	2,843	609	...
Telegraph Department	...	299	299	...
TOTAL	75,855	2,23,662	1,51,590	3,783
NET DEBIT	...	...	1,47,807	...
CASH SALES	...	...	33,890	...
GRAND TOTAL	...	...	1,81,697	...

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1894-95.

SPECIFICATION.	No.	Value.	
		R	*a.*
INSTRUMENTS.			
Barometer, aneroid, ordinary, 4½-inch	1	75	0
,, ,, ,, pocket	1	75	0
Cases, leather and morocco, spare	74	121	8
Chains, iron, 66 feet	131	458	8
,, steel, 100 ,,	20	220	0
,, ,, 66 ,,	22	176	0
Chronographs, watch pattern	3	74	0
Clinometers, Watkin's ,,	12	231	0
,, Survey ,,	6	81	0
Clocks	1	75	0
Compasses, bow, ink, electrum, single jointed	101	530	0
,, ,, ,, ,, ,, spring	7	23	8
,, ,, sets, spring	3	21	12
,, drawing, ordinary brass, 5-inch	217	190	0
,, ,, with pen and pencil, points brass, 6-inch	14	68	4
,, magnetic, pocket, in brass case	9	220	8
,, ,, rectangular, 2½-inch	12	72	0
,, ,, ,, 5-inch	136	1,643	0
,, ,, ,, 6-inch	110	1,475	0
,, prismatic, silver ring, 4-inch	1	90	0
Covers for planetables	25	144	0
Glasses, binocular, telescopic	2	100	0
,, magnifying or reading, in metal frame, 3-inch	5	20	0
,, ,, ,, ,, ,, ,, 3½-inch to 4½-inch	15	76	8
,, time	1	3	8
Ghât tracers, Ceylon pattern	4	211	12
Hold-alls, leather	24	84	0
Hydrometers, Syke's, brass floats, sets	5	300	0
,, ,, glass ,, ,,	1	70	0
Hygrometers, Mason's	7	111	0
Instruments, drawing, brass, 2nd sort	3	108	0
,, ,, ,, 3rd ,,	2	46	0
,, ,, electrum, 1st sort, with needle points	6	495	0
,, ,, ,, 2nd ,,	3	156	0
Levels, gradient, telemeter	3	1,300	0
,, reflecting, Abney's	6	216	0
,, reversible, 12-inch	1	250	0
,, ,, 14-inch	8	2,150	0
,, spirit, in wooden cases, 10-inch	30	86	4
,, ,, ,, ,, ,, 12-inch	12	30	0
Map-printing machine, Ordnance	12	525	0
Curves, Railway, Celluloid, large, sets	3	84	0
,, ,, ,, small, ,,	3	45	0
Pens, drawing, ivory handles	497	1,280	11
Pins for chains, ordinary	16,000	1,000	0
Planetables, Survey	76	532	0
Protractors, rectangular, ivory, 6-inch	12	34	8
,, ,, wooden	36	29	4
Range Finders	4	328	5
Rules, carpenters, wooden, 2-foot 4-fold	144	162	0
,, flat ebonite, plain, 12-inch	1,150	754	11
,, parallel, on rollers, brass, 12-inch	3	57	0
,, ,, ,, ,, 18-inch	3	93	0
,, sight, wooden	662	1,986	0
Scales, architects, boxwood, sets	2	30	0
,, ,, ,, single	12	33	0
,, diagonal, 6 inches to the mile	4	3	14
Carried over	19,667	18,857	5

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1894-95—contd.

Specification.	No.	Value.
		R *a.*
Brought forward .	19,667	18,857 5
Scales diagonal wooden	2,000	1,125 0
„ Engineering, wooden, single	3	17 4
„ offsets, single, ivory	1,502	657 2
„ plotting, sets, wooden	5	86 0
„ „ single, wooden	12	26 4
Set, squares, single, ebonite	12	9 12
Squares, optical	937	6,085 8
Stands for prismatic compass, 4-inch	1	20 0
„ „ level, dumpy	12	518 10
„ „ planetable, survey pattern	834	5,838 0
„ „ theodolites, transit, Railway, 6-inch	3	165 0
Telescopes of various sorts	10	300 0
Theodolites, transit, Railway, 6-inch, with vernier circle . .	3	2,460 0
Thermometers, chemical, or travellers	6	39 0
„ clinical	2	9 0
„ common, in tin cases	1	11 8
„ grass	1	12 8
Thermometer, maximum, self-registering	19	282 12
„ minimum	7	99 0
„ oven	3	75 0
Trunks, mule	24	351 0
Umbrellas, surveying	55	825 14
TOTAL .	25,119	37,871 7
Books.		
Hints to Travellers	16	95 5
Manual of Surveying	3	36 0
Nautical Almanacs	120	258 6
Tables, traverse, Boileau's	16	157 4
TOTAL .	155	546 15
Sundries.		
Brushes, stencil, medium size	24	12 0
Engine divided steel rulers	10	30 0
Rotating pen and pencil	1	15 0
Letter balances	3	71 13
Strong candle lantern	1	5 12
Glasses for candle lantern	1	2 8
Tapes for Weldon's range-finders	3	25 6
Badges for *khalasis*	36	18 0
Steel yards	6	220 0
Levels, circular	9	26 14
Stencil ink, black	12	6 0
Type-writers	2	151 10
Brass frames and fittings for clinometers	4	66 0
Charts for thermometers	150	37 8
Thermometers, maximum and minimum, with magnet . .	4	40 0
Glasses, ink, bottles	24	7 8
TOTAL .	290	735 15
TOTAL OF BOOKS . .	155	546 15
„ OF INSTRUMENTS .	25,119	37,871 7
SUM TOTAL .	25,564	39,154 5

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1894-95.

SPECIFICATION.	Number.	Value.	
		₹	a.
Instruments.			
Bars, standard, steel, 6-foot	2	64	0
Boards, drawing, deal	41	588	0
Cards for marine compasses	1	15	0
Chains, iron, 30 feet	111	277	8
„ „ 33 „	50	125	0
„ „ 50 „	4	14	0
„ „ 66 „	952	3,398	0
„ „ 100 „	18	119	8
„ steel	129	1,302	0
„ of sorts and sizes	11	53	0
Clinometers, survey pattern	12	360	0
Combs, acre, card-board	3,128	1,173	0
Compasses, magnetic, rectangular, 4-inch	24	264	0
„ „ „ 5-inch	86	1,130	0
„ „ „ 6-inch	62	930	0
Glasses, copying or tracing	20	751	8
Hold-alls, leather	72	1,248	0
Holders for type and conventional signs	3	65	0
Ink-rollers	5	10	0
Lamps, bulls-eye	2	20	0
„ referring	40	222	0
Pins for chains, ordinary	7,420	552	8
Plane-tables, deal, survey	644	4,431	8
„ „ military	1	60	0
Plates, Graticule	3	155	0
Pluviometers, Symon's	163	1,059	0
Protractors, card-board, circular, 5-inch	300	75	0
„ „ „ „ 12-inch	150	143	12
Rods, measuring	30	58	8
Rules, flat, ebonite, plain	9	6	12
„ „ wooden	6	18	0
„ parallel, on rollers, brass, 18-inch	12	288	0
„ sight, wooden	75	225	0
Scales, Bengalee, card-board	200	25	0
„ „ metal	150	187	8
„ card-board, miscellaneous	2,200	550	0
„ diagonal, card-board	5,100	1,268	12
„ „ metal, 6 inches to the mile	86	486	0
Sheets, celluloid	805	482	4
Scales, offsets, single ivory	13	4	14
Stamps for conventional signs	30	60	0
Stands for heliotropes	24	384	0
„ „ plane-tables, survey pattern	61	427	0
„ „ telescopes, metal	1	36	0
„ „ theodolites, 8-inch	1	50	0
Staves, levelling, Roorkee, double	6	150	0
„ „ „ single	50	700	0
„ „ Sopwith's telescopic	42	1,020	0
„ subtense	12	300	0
Stencil plates, various	193	324	10
Sundial	1	50	0
Thermometers, chemical, or travellers'	3	27	0
TOTAL	22,564	25,735	8
Sundries.			
Cups for rain-gauges	8	28	0
Tables, large, 5 feet square	6	150	0
Carried over	14	178	0

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1894-95—contd.

SPECIFICATION.	Number.	Value.
		ℛ a.
Sundries—contd.		
Brought forward .	14	178 0
Scales, metal, large, 3 feet 6 inches=1 mile	6	225 0
Major Kelley's plotting instruments	2	145 0
Metal pan of balance	1	2 8
Blotters	4	10 0
Observing arc for Fulta	1	75 0
Handles for chains	40	10 0
Plane-tables screws	15	15 0
Rings for chains	500	5 0
Links for chains	500	10 0
Nuts and bolts for plane-table stands	24	24 0
Turn screws for compass	1	0 4
Zinc mullers	12	18 0
Screw-drivers	84	50 0
Plates for plane-tables	50	175 0
Pressler's borers	1	8 0
Stands for Altazimuth Compass	6	12 0
Diamonds for subtense bar	6	27 0
Washers	9	
Bars	60	
Turn screws	50	115 0
Screw with nuts	24	
Nuts with washers	36	
Snow-gauges	10	82 0
Capstan bar for instruments	2	0 4
Brass plates and screws for plane-tables	6	21 0
Funnel for 5-inch rain-gauge	1	4 8
Screw tightener for instrument box	1	0 2
Instrument for Exchange calculation	1	50 0
Cases for barometers	2	4 8
Frames with glass for Ferrotype printing	2	94 12
Boxes, deal wood	5	7 8
Plummets, brass	24	55 0
TOTAL .	1,500	1,424 6
TOTAL OF INSTRUMENTS .	22,564	25,735 8
SUM TOTAL .	24,064	27,159 14

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year 1894-95.

SPECIFICATION.	Number.
Anemographs	2
Anemometers	24
Arithmometers	2
Barometers, of sorts	81
Boards, drawing	1
Chains, of sorts	156
Chronographs	6
Chronometers, of sorts	8
Chronomicrometers	2
Clinometers, of sorts	114
Clocks	8
Compasses, beam	5
„ boat	5
„ bow pens, of sorts	66
„ „ pencils, of sorts	9
„ „ sets, spring	1
„ with pen and pencil points	4
„ drawing, of sorts	239
„ „ hair, of sorts	8
„ magnetic pocket	9
„ „ rectangular, of sorts	103
„ pillar and Bonsella	2
„ prismatic, of sorts	145
„ proportional, of sorts	7
„ ship	1
„ surveying, of sorts	36
Declinometers	1
Glasses, binoculars	24
Ghat tracers	2
Heliographs	16
Heliotropes	9
Holders for type	2
Horse measuring machines	2
Horizon, artificial	1
Hydrometers	52
Hygrometers	3
Instruments, drawing, mathematical, of sorts	49
Instruments, time of flight	5
Knives for Instrument boxes	4
Lamps, of sorts	17
Lenses, of sorts	3
Levels, of sorts	177
„ spirit	2
Lithographic machines	2
Magnet bar	1
Map printing machines	4
Mekometers	5
Micrometers	3
Meters, current	1
Pens, drawing, of sorts	190
Pentagraphs	2
Perambulators	1
Pins for chains, of sorts	136
„ for maps, of sorts	6
Planetables	44
Planimeters	9
Pointers, station	2
Presses, of sorts	2
Prickers	2
Carried over	1,823

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year 1894-95—contd.

SPECIFICATION.	Number.
Brought forward	1,823
Protectors, of sorts	2
Pluviometers	9
Pyrometers	3
Quintants, sounding	2
Range finders	23
Reflectors	1
Rules, of sorts	78
„ sight, of sorts	171
Saccharometers	17
Sand glass	1
Scales, of sorts	23
Scotts sight, B.L., telescopic	131
Sector	1
Sextants, of sorts	16
Squares, of sorts	162
Stands for compasses, of sorts	64
„ „ heliographs	3
„ „ levels	83
„ „ planetables	47
„ „ theodolites	39
Staves, levelling, of sorts	190
Sympiesometer	1
Tapes, of sorts	355
Telescopes, of sorts	117
Theodolites, of sorts	93
Thermometers, of sorts	33
Type writers	11
Vane sight	1
„ wind	2
Watches, of sorts	12
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED	3,514
„ „ MINOR INSTRUMENTS REPAIRED	893
TOTAL OF ALL INSTRUMENTS REPAIRED	4,407

MATHEMATICAL INSTRUMENT OFFICE.

Profit and Loss account of the Workshop for the financial year 1894-95.

DEBITS.			CREDITS.		
	R	a.		R a.	R a.
To Workshop Establishment (less proportion debitable to the Store Branch for cleaning and adjusting of serviceable instruments) .	32,027	11	By Repairs for Public officers on book debit	11,118 2	
„ One-third of office establishment . . .	2,619	6	„ Repairs for public officers on payment .	7,549 14	18,668 0
„ Pay of Material Storekeeper for the whole year	780	0	„ repairs for stock . .		26,361 12
„ Workshop contingencies as distinguished from materials purchased . .	2,238	6	„ manufactures for stock — instruments . .		25,341 6
			packing cases . .		1,318 7
„ Value of materials — For ordinary work . . „ general workshop use „ manufacture of packing cases . .	21,489	14	„ manufacture of materials		3,623 8
„ Paid for repairs . .	154	10			
„ Wear and tear of Plant .	1,564	1			
„ Half of rent at R600 per mensem . . .	3,600	0			
„ Printing and stationery .	448	5			
„ Four per cent. on value of tools and plant amounting to R1,11,087-7 . .	4,443	8			
„ Half of taxes, rates, etc. .	877	0			
„ Liability of pensions .	3,948	0			
„ Profit	1,122	4			
	75,313	0	TOTAL .		75,313 0

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Narrative Report of MR. J. ECCLES, M.A., *Officiating Deputy Superintendent, 1st grade, in charge Computing Party, Season 1894-95.*

During the year the alterations to the office buildings, mentioned in last report, were undertaken. There was some delay in commencing, and the rains interfered considerably, so that the work is not yet quite completed. As the old press-rooms of the Photo-zincographic Section were dismantled, it was necessary to provide accommodation for the presses elsewhere: the closed-in verandah of the stores godown was utilized for this purpose, and in spite of cramped space and bad light, the work was carried on continuously. In the main building only three rooms were left intact, and these were occupied by the computers and draftsmen. In the room occupied by the former the records were stored in temporary racks; the library books were packed in boxes and stored away in the large Solar Photo observatory, which was also used as an office by the Superintendent, Trigonometrical Surveys, and the Officer in charge Computing Party.

The buildings, when completed, will afford moderately good accommodation for the Photo-zincographic Section; the new press-rooms are airy and well lit. The new camera room is expected to answer all requirements, though from its structure it will of necessity be hot at some seasons of the year. A neat arrangement has been devised by Lieutenant-Colonel St. G. C. Gore, R.E., for mounting maps in front of the cameras, so as to obviate the necessity of taking down maps and repinning them on the board. There are two sets of hooks on the board, which are so arranged that when the board is suspended by either, the proper part of the corresponding half of the map comes into the axis of the camera. An extra lateral movement is given to the whole framework: it is at present worked by hand, but it is intended eventually to fit it either with a lever or a screw.

It has been found impossible, under the new condition of things, to allot a separate room to the Library: the books will be placed on shelves in the computing and drawing rooms, and it is hoped that no great inconvenience will be caused by this change.

The room formerly occupied by the Officer in charge Computing Party will no longer be available for that purpose; part of the north verandah has, therefore, been glazed in to afford accommodation for that officer.

The *personnel* of the office underwent still further alterations during the year. Mr. Manuel, the Assistant Zincographer, had to go on sick leave, and as it was impossible to get a skilled man to take up a temporary post, the latter, that of Zincographer, had to be made permanent and the post of Head Printer made temporary. In consequence of these changes, Mr. Manuel was made Zincographer, and Mr. G. A. Le Franc brought from the Calcutta Office to act as Assistant Zincographer, while the Head Printer, Mr. Hughes, was retired on a superannuation pension.

In March 1895 the writer Munshi Abdul Rahim died, and his place was filled by the appointment of Babu Hriday Chandra Das, formerly a temporary computer in this office and afterwards a clerk in the office of the Director of Bengal Surveys.

In the course of the last season's latitude operations it came to light that the values of the divisions of the micrometer screws were altered considerably by changes in temperature. To test to what extent this was the case, a series of experiments was undertaken in the hottest weather and will be continued in the cold weather. The instrument experimented on was one of the Zenith sectors, and the procedure was as follows:—the eye end was turned round through one right angle, so that the micrometer wire was parallel to the meridian, and transits were taken over it, in positions differing by 20 revolutions of the screw, and recorded in the usual way by electric signals on a chronograph. The experiments are not sufficiently advanced for discussion.

The new 8-inch theodolite by Messrs. Troughton and Simms, which was sent up for trial with the Pamir Delimitation Commission, has been very favourably reported on. It is essentially the vernier pattern 8-inch theodolite with verniers replaced by micrometers, two to each limb, mounted on aluminium brackets. The limbs are graduated to 10′ and the micrometer heads divided into 60 parts, so that each division is 10″, and therefore the limb can be read by estimation to seconds. The limb is so figured that the degrees can at once be read in the micrometers, thus avoiding the necessity of a pointer microscope. It is very little heavier than the ordinary 8-inch theodolite, and admits of the production of much more accurate work.

Owing to the above-mentioned changes in the Photo-zincographic and Printing Sections, the amount of the permanent grant is now divided among the sections as follows:—

	₹	
(1) Computing Section	13,404	Per annum.
(2) Printing Section	3,696	
(3) Photo-zincographic Section	19,080	
(4) Correspondence Section	5,232	
(5) Stores, Workshops and Observatories Section	2,724	
(6) Drawing Section	4,316	
(7) Solar Photographic Section	2,106	

The cost of the Computing Section under its various class heads and the percentages thereof, together with those of the three preceding years, are given in the following statement:—

Class.	Cost in Rupees.	Percentage of cost.			
	1894-95.	1894-95.	1893-94.	1892-93.	1891-92.
	R				
1. Records, Library	1,089	3·4	1·4	2·6	3
2. Accounts, Returns, Correspondence	2,613	8·1	7·1	5·4	4
3. Supply of data, etc.	866	2·7	3·0	2·3	3
4. Computations	8,023				
5. Preparation of Press copy	7,777	75·8	78·6	79·5	79
6. Examination of Press proofs	8,550				
7. Ditto of charts	428	1·4	0·6	1·5	2
8. Protection of stations	682	2·2	1·2	1·2	1
9. Miscellaneous	1,380	4·3	6·2	6·2	6
10. Meteorology, etc.	615	1·9	1·3	1·1	1·7
11. Extra-departmental work	64	0·2	0·6	0·1	0·3
	32,087	100	100	100	100

The following is an account of the work done under the several classes shown in the foregoing table :—

Class 1.—Records, Library, etc.—Five fresh instalments of field records were received during the year; these, together with the great mass already stored in the office, have received the usual care and attention. The three standard copies of the library catalogue have been kept up to date. On account of the alterations to the office buildings, the greater part of the records had to be removed to another room, and the library books stored away in boxes. This accounts for the increased percentage under this class.

Class 2.—Accounts, Returns, and Correspondence.—In this is included the preparation of indents, estimates, monthly detailed and abstract progress reports, annual reports, stock returns of office stores, and various other items. The increased percentage under this head is due to the absence on sick leave of the writer, whose duties had to be performed by a computer.

Class 3.—Supply of Data.—The demand for this was as usual, with the exception of the data required for the Chitral Relief Force, which necessitated some heavy transcription, and that supplied to the Pamir Delimitation Commission and the Anglo-Afghan Boundary Commission, which, though not extensive, required considerable care in looking up the manuscript records. In all, fifteen requisitions were received and complied with during the year.

Class 4.—Computations.—These will be found detailed below; they mostly appertain to the secondary work of the North-East Longitudinal Series.

North-East Longitudinal Series.—Angles of about 400 triangles were deduced; and of this number about 120 triangles were finally computed and adjusted; spherical excess for 142 triangles, and latitude, longitude and azimuths of 44 points, were computed. Of the 22 angle books remaining to be examined and completed with regard to their abstracts, as reported last year, only one book could be finished owing to the computers being required for other urgent work.

Municipality Survey for the towns of Gurgaon and Sohna.—The examination of the field books, and the computation of the following, were completed :—

6 main circuits;
10 sub-circuits;
37 traverses;
18 deductions of observed azimuths.

Electro-telegraphic Longitudes.—One computer was engaged for three months in assisting in the reduction of the observations of season 1894-95.

The rest of the work of this class was of miscellaneous character.

CLASS 5.—PREPARATION OF PRESS COPY.—This entails abstracting and compiling the final results of the various calculations in a suitable form for publication; all such compilations are twice compared, once against the original field records, and once against the final calculations, prior to being sent to the press.

The details of the work done are as follows:—

(*a*) *Southern Trigon.*—Some further progress has been made with the preparation and final revision of the several statements for the Synoptical Volume of the Great Arc Meridional Series, Section 8° to 18°; it may be considered about three-fourths done.

(*b*) *The pamphlets of Spirit-levelled Heights.*—No. 8, Central Provinces and Orissa, and Karachi and its neighbourhood, were examined and passed for the press.

(*c*) *Hand-Book of Professional Instructions for the Topographical Branch, second edition.*—Examination of some 40 pages completed.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This requires the utmost care in comparison and examination in the several stages of first, second and form proofs. Most of the matter printed is numerical, or depending on numerical data; hence it necessarily involves a strictly critical examination, which can only be given by men specially trained to this style of work.

The printing of the following works has been completed during the year:—

(1) Spirit-levelled Heights, Karachi and its neighbourhood.
(2) Spirit-levelled Heights, No. 8 Central Provinces and Orissa.
(3) Imperial Forest school Calendar 1895.

Nos. (1) and (2). as also Synoptical Volume XXXIV (which only needed the charts were bound, examined and issued to the several recipients as usual.

CLASS 7.—EXAMINATION OF CHARTS.—The following charts were compared, examined and passed for the press:—

2 Charts, Káthiáwár Meridional Series.
2 Charts, Spirit-levelled Heights.
1 Chart, Preliminary, No. 45, of Indus Delta.

CLASS 8.—PROTECTION OF STATIONS.—The usual professional work in connection with the protection of Survey stations and certain of the bench-marks in the North-Western Provinces was performed. During the year, 610 stations have been repaired by the district officers at a cost of R2,071-3-7. Twenty-one districts out of 346, from which reports are due, failed to submit them.

CLASS 9.—MISCELLANEOUS.—In this is included various duties which cannot be fairly assigned to any of the other classes, such as the following:—

(*a*) The examination and despatch of printed papers to the Survey of India Office, Calcutta, for safe custody.

(*b*) The examination of all bound volumes and pamphlets prior to issue, and the preparation of the distribution lists and presentation label for the same.

(*c*) The preparation of examination papers for the Provincial Service of the Survey of India Department, of which 38 sets were prepared and examined, and the results tabulated for submission to the Surveyor-General.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.—As hitherto, a complete set of meteorological observations was taken daily throughout the year, and monthly and annual abstracts prepared. One officer of the Meteorological Department was instructed in the use of the transit instruments, and in Solar Photography. The meteorological results are given in the following tabular statements:—

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1894-95	77·00	76·87	76·71	76·34	75·81	74·91	74·14	73·75	73·63	73·88	75·18	76·11
	Mean 1881—94	76·79	76·85	76·65	76·01	75·46	74·87	74·32	74·04	74·01	74·35	75·55	76·53
12·8	1894-95	79·27	78·46	76·55	73·94	71·40	70·24	70·78	72·29	74·63	76·73	78·78	79·47
	Mean 1881—94	79·41	77·99	75·68	73·08	71·43	70·65	71·28	73·08	75·18	77·16	79·08	79·64
6·4	1894-95	79·92	76·22	71·51	66·14	64·60	66·93	70·57	75·89	80·24	81·01	81·35	81·16
	Mean 1881—94	79·63	75·65	71·02	67·21	65·46	67·02	71·49	76 71	80·13	81·25	81·35	81·15
3·2	1894-95	78·66	71·38	64·24	60·09	60·66	67·47	73·47	82·47	84·42	83·17	81·70	82·13
	Mean 1881—94	78·06	71·54	65·54	61·90	61·22	66·50	75·39	81·76	84·61	83·28	82·03	81·51
1·1	1894-95	77·01	67·07	58·50	55·77	59·38	68·70	75·34	87·68	86·57	84·48	82·01	81·94
	Mean 1881—94	75·95	67·28	60·14	57·26	58·38	67·34	78·75	85·46	87·81	83·98	82·33	81·50
Thermometer in shade.	1894-95	79·58	70·29	62·40	61·22	69·11	79·02	84·19	95·73	84·95	83·27	81·06	83·15
	Mean 1881—94	80·46	73·48	68·16	64·09	66·70	78·39	90·03	93·48	90·46	82·22	80·57	82·28

Mean velocity in miles of the Winds which blew at Dehra Dun during the twelve months of 1894-95 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1 .	0·48	0·60	0·53	0·77	1·96	1·20	0·87	0 77	1·10	0·57	0·48	0·73	0·84
1 „ 2 .	0·42	0·52	0·17	0·77	1·36	1·23	0·77	0 74	0·93	0·37	0·35	0·37	0·67
2 „ 3 .	0·29	0·34	0·40	0·63	1·25	0·93	0·63	0·65	1·21	0·13	0·42	0 47	0·61
3 „ 4 .	0·13	0·41	0·43	0·87	1·18	1·43	0·53	0·29	1·03	0·53	0·45	0·53	0·65
4 „ 5 .	0·23	0·21	0·47	0·80	1·04	1·17	0·43	0·39	1·34	0·53	0·29	0·57	0·62
5 „ 6 .	0·10	0·14	0 53	0·73	1·00	0·77	0·43	0·52	0·97	0·33	0·16	0·33	0·50
6 „ 7 .	0·16	0·14	0·30	0·63	0·79	0·60	0·67	0·90	0·97	0·37	0·13	0·23	0·49
7 „ 8 .	0·10	0·10	0·27	0·67	1·00	0·72	0·43	0·29	0·66	0·63	0·35	0·13	0·45
8 „ 9 .	0·16	0 14	0·41	0·70	0·50	0·79	0·90	1·06	1 24	0 65	1·06	0·17	0·65
9 „ 10 .	0·32	0 55	0·59	0 97	1·21	1·28	1·57	2·00	1·67	0·71	1·06	0·67	1·05
10 „ 11 .	0·74	0·80	0·85	1·37	2·29	1·93	2·03	2·03	2·20	1·16	1·23	0·80	1·45
11 „ 12 .	1·03	1·10	1·10	1·74	2·11	2·17	1·97	2·13	2 30	1·29	1·20	1·93	1·60
12 „ 13 .	1·00	1·40	1·58	2·00	0·46	2·68	2·23	2 55	2 57	1·45	1·16	1·33	1·87
13 „ 14 .	1·13	1·43	1·45	2·90	3·00	3·61	2 33	3·03	2·60	1·39	1·55	1·63	2·17
14 „ 15 .	1·26	1·20	1·89	2·48	3·04	3 42	3·17	3 39	3·23	1·32	1·65	1·63	2·27
15 „ 16 .	1·00	0·73	1·39	2·10	3·25	3·10	3·63	3·32	2·60	1·07	1·42	1·43	2 09
16 „ 17 .	0·58	0·23	0·68	1·97	2·96	2·81	2·70	3·58	2·07	0·84	0·87	1·67	1·66
17 „ 18 .	0·23	0 03	0·32	1·03	1·96	0·87	1·63	2·13	1·80	0·47	0·71	0·40	0·97
18 „ 19 .	0·68	2·17	0 29	0·87	0·68	0 39	0 83	0·87	1·33	0·43	0·29	0·17	0·58
19 „ 20 .	0·94	0·43	0·47	0·50	1·29	0·48	0·63	0.65	0·63	0 33	0·42	0·30	0·59
20 „ 21 .	1·06	0·60	0·53	0·53	2·04	0·87	0·93	0 61	0·83	0·17	0 39	0·27	0·74
21 „ 22 .	0·77	0·77	0·40	0·80	2·07	1 23	1 43	1·06	0·87	0·40	0·48	0·43	0·89
22 „ 23 .	1·00	0·67	0·40	0·67	2·11	1·27	1·30	0·84	1·37	0·33	0·39	0·43	0·90
23 „ 24 .	0·68	0·70	0·40	0·87	2·04	1·43	1·37	1·00	1·21	0·37	0·52	0 57	0·93
Sums .	14·49	13·41	15·30	27·37	42·59	36·38	33·41	34·80	36·73	15 84	17·03	15·29	...
Average .	0·60	0·56	0·64	1·14	1·77	1·52	1·39	1·45	1·53	0·66	0 71	0·64	...

Monthly Meteorological Results of observations taken at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer reduced to 32° Fah.						Hygrometer.		Thermometer.			Wet Bulb.	Rain.		Wind.	Cloud.	
	At 10 A.M.			At 4 P.M.			10 A.M.	4 P.M.	Dry Bulb.								
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean humidity.	Monthly mean humidity.	Highest maximum in air.	Lowest Minimum in Air.	Monthly mean in air.	Lowest Minimum.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 10 A.M.	At 4 P.M.
1894.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	°	°	°	°	°	°					
October	27·775	27·518	27·657	27·691	27·426	27·569	62	56	87·1	54·5	71·1	51·3	3 days.	4·19	Calm.	1·2	2·3
November	27·932	27·681	27·807	27·836	27·619	27·735	62	59	79·9	47·5	61·3	44·5	2 „	1·26	„	2·4	5·0
December	27·966	27·729	27·830	27·858	27·578	27·742	69	64	72·6	40·3	53·7	39·0	7 „	3·91	„	5·2	5·7
1895.																	
January	27·909	27·680	27·795	27·839	27·539	27·712	74	58	69·5	38·2	52·8	37·2	7 „	3·69	Calm & W.	5·9	6·0
February	27·902	27·637	27·765	27·776	27·570	27·685	57	46	78·4	38·9	57·5	37 8	3 „	2·81	S. W.	1·0	2·5
March	27·830	27·517	27·664	27·746	27·474	27·584	49	38	87·9	48·7	67·2	44·3	1 „	0·25	S. S. W. & W.	3·1	4·5
April	27·781	27·337	27 629	27·663	27·229	27·522	48	38	99·5	53·4	74·0	49·5	4 „	1·42	S. W.	3·6	5·4
May	27·716	27·275	27·493	27·602	27·212	27·396	40	32	106·4	64·1	84·8	57·2	3 „	1·14	S. & S. W.	1·5	2·0
June	27·616	27·342	27·455	27·488	27·270	27·373	68	65	97·9	67·2	80·0	62·7	14 „	15·61	S. E.	6·0	7·0
July	27·547	27·265	27·402	27·436	27 221	27·316	80	74	91·2	67·5	78·1	66·4	18 „	16·19	Calm.	6·8	6·7
August	27·531	27·315	27·435	27·447	27·237	27·358	83	81	90·3	69·0	76·7	68·1	20 „	37·67	Calm.	7·6	8·0
September	27·695	27·440	27·586	27 621	27·372	27·497	70	64	88·3	63·0	76·3	58·4	7 „	4·29	Calm.	8·4	4·2

CLASS II.—EXTRA-DEPARTMENTAL WORK.—The only work under this head was the reduction of certain observations for longitude taken by an officer which were sent by the Quarter Master General.

TYPE-PRINTING SECTION.—As will be seen from the annexed statement the greater part of the work done consisted in printing forms, professional and others, for the Department, and in setting up the large number of small headings, foot-notes, etc., required in the Drawing Section in connection with the publication of maps.

Statement of work done during 1894-95.

SPECIFICATION OF PRINT.	No. of pages.	Total No. of pulls.	No. of copies of each page.	VALUE.
				£
Professional volume	36	5,330	510	987
Synoptical volume	51	5,600	360	1,184
Pamphlets of Spirit-levelled heights	97	6,770	350	1,463
Letter-press for charts, map-headings, and foot-notes	359	6,280	...	2,180
Forms	500	127,762	...	9,684
Extra-departmental work	170	22,650	...	315
Exploration Report	20	450	50	308
TOTAL	1,233*	174,842	...	16,121

* Equal to 1,219 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1890-91.	1891-92.	1892-93.	1893-94.	1894-95.
Pages composed	2,165	2,228	2,195	1,638	1,219

The outturn during the year, considering the reduced establishment, is very satisfactory.

An analysis of the pages composed in 1894-95 is as follows :—

PROFESSIONAL VOLUME	Tidal Volume	72
	TOTAL	72
SYNOPTICAL VOLUME	Great Arc Meridional Series	85
	TOTAL	85
MISCELLANEOUS	Spirit-levelled heights in Karachi and its neighbourhood, and No. 8 Central Provinces and Orissa	97
	Letter-press for charts, map-headings, and foot-notes	193
	Forms, orders, memoranda, etc.	612
	Extra-departmental work	139
	Exploration Report	20
	TOTAL	1,061

PHOTO-ZINCOGRAPHIC SECTION.—In January 1895 the new plant arrived, and in consequence the arrears of work have been cleared off, and the current work is well advanced. In March and April, a great deal of extra work was thrown on the section owing to the sudden demand for maps for the Chitral Relief Force. As the demand was very urgent, the whole strength of the section was devoted to this work, and by working overtime 6,680 pulls were made in 17 days.

The chemical graining of zinc plates, as practised at the head-quarters office in Calcutta, has not been adopted so far owing to the expense of carriage of chemicals, and to the fact that the number of plates required at any one time is not great, and it is on the whole cheaper to employ manual labour.

The following tables exhibit the value and outturn of work done by the section :—

Statement showing the amount of work done for other Departments, etc., during the year 1894-95.

Departments, etc.	Photo-zincographic Printing.							
	Sheets, sections or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.
Forest Department	168	304	302	155	...	30	15,659	17,381
Foreign Department	3	8	8	3	...	...	170	110
Quarter Master General	10	16	50	26	...	...	7,134	1,861
Special work done for private individuals	3	1	1	1	...	...	680	1,710
Totals	184	329	361	185	...	30	23,643	21,062

Table showing the amount realized from other Departments, etc., by Book-debit and Cash sales during 1894-95.

Departments, etc.	By Book-debit.		By Cash sales.		Total.	
	₹	a.	₹	a.	₹	a.
Forest Department	401	4	276	3	677	7
Forest Survey	8,466	14	185	6	8,652	4
Quarter Master General	2,042	0	113	15	2,155	15
Military Department	115	3	168	8	283	11
Other Departments	...		238	0	238	0
Private individuals	...		173	7	173	7
Total	11,025	5	1,155	7	12,180	12

Statement of Departmental work done during the year 1894-95.

Specification of Plate or Print.	Progress made.	Photo-zincographic Printing.											Remarks.
		Scale of map.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.	
		1 inch = miles.										R a.	
Allahabad, Sketch map of country within 10 miles around	* F.	1	D. E.	1	...	6	1	...	...	50	50	53 8	
Central Provinces Survey Sheets Nos. 5 N.E./2, N.E./4; S.E./1 and S.W./2 (in one), S.E./2, S.E./3, S.E./4, S.W./4; 6 N.E./1, N.E./2, N.E./3, N.E./4; N.W./3 and N.W./4 (in one), S.W./4; 7 S.E./1, S.E./2, S.E./4; 11 N.W./1 N.W./2; N.W./3 and N.W./4 (in one), S.W./1, S.W./2, S.W./3, S.W./4; 12 N.W./3 and N.W./4 (in one), S.E./3, S.E./4; 13 N.E./1 and N.W./2 (in one), N.E./2, (2nd Edition), N.E./3; N.E./4 and S.E./2 (in one), N.W./4, S.E./1; S.E./3 and S.W./4 (in one), S.W./1, S.W./2, S.W./3; 14 N.W./2; 15 N.W./3 and N.W./4 (in one); and 34 S.E./2	F.	¼	D. E.	39	79	79	39	...	...	5,850	5,850	2,646 8	
Chart and Compass Race	F.	½	¼ D. E.	1	1	...	...	...	20	...	20	17 11	
Clinometer Height Indicator and Contouring Scale (Captain Wahab's)	F.	...	1/16 D. E.	1	...	...	...	...	...	255	510	18 0	
Cochin, Tidal Diagram	F.	...	⅛ D. E.	1	1	2	1	...	...	255	510	45 8	For Professional Volume (Tidal).
Conventional Signs, Diagram	F.	...	...	1	1	2	1	...	...	20	40	13 9	
Cutch Survey, Sheet No. 23	* F.	1	D. E.	1	...	9	1	...	...	53	53	57 10	
Dehra Dún and Siwáliks Survey, Sheets Nos. 1, 2 and 3	* F.	1	D. E.	3	...	...	...	...	...	150	150	32 4	
Dehra Dún with Mussooree and Landour, Map	* F.	¼	D. E.	1	2	2	1	...	...	100	100	56 14	
Eastern Frontier Series, Preliminary Charts, Seasons 1865-66 and 1868-69	* F.	4	D. E.	2	8	8	2	...	...	125	125	97 8	
Form for Departmental use (Miscellaneous)	* F.	...	...	1	...	...	...	...	...	100	200	10 3	
Gujarát Survey, Sheets Nos. 10; 27 N.E. Section, S.E. Section 2, Section 4; 28 N.E. Section, S.E. Section, Section 2; 31; 77; and 81	* F.	1, ½ & 1	D. E.	11	66	66	11	...	...	981	981	991 5	
Index to the Forest Survey in the District of Damoh, Central Provinces	F.	10	⅛ D. E.	1	2	2	1	...	...	42	42	24 0	
Indus Delta Coast Triangulation, Preliminary Chart, Sheet No. 45	F.	2	D. E.	1	6	6	1	...	...	60	60	83 12	
Kalka Town Survey, Sheets Nos. 1, 2, 3, 4, 5 and 6	F.	...	D. E.	6	36	36	6	...	...	1,300	1,300	691 12	
Káthiáwár Meridional Series, Final Chart, Sheets Nos. 1 and 2	F.	8	D. E.	2	13	13	2	...	...	720	720	221 5	For Synoptical Volume XXXIV.
Káthiáwár Survey, Sheet No. 10A (2nd Edition)	* F.	1	D. E.	1	9	9	1	..	...	150	150	130 1	
Korea, Map of	F.	...	¼ D. E.	1	1	1	1	...	...	50	50	20 6	
Kumaun and Garhwál Survey, Sheets Nos. 19, 22 and 25; and Shaded Sheets Nos. 15, 21, 23, 24, 26, 27, 32 and 34	* F.	1	D. E.	11	44	56	11	...	...	550	550	714 2	
Mandalay Meridional Series, Preliminary Chart of Principal Triangulation, Sheet No. 5, Season 1893-94	F.	4	D. E.	1	8	8	1	...	...	60	60	104 2	
Mussooree and Landour Survey, Sheets Nos. 9 and 17 (Shaded)	* F.	1/12 & 1	D. E.	2	12	12	2	...	...	60	60	152 14	
Mussooree Cemetery, Map	F.	...	D. E.	1	8	8	1	...	...	75	75	100 10	
Pegu, Rangoon and Coast, Chart, Season 1875-76	* F.	4	D. E.	1	8	8	1	...	...	75	75	106 0	
Punjab, Triangulation Charts, Sheets Nos. 290 (with Letter Press) and 313 (with Letter Press)	F.	2 & 4	D. E. & ½ D. E.	2	8	8	2	...	...	100	100	108 2	
Punjab Survey, Sheets Nos. 246 (N.E.)1, (N.E.)2, (N.E.)3, (N.E.)4, (N.W.)4, (S.E.)1; 264 (N.E.)1, (S.E.)1, (S.E.)3, (S.E.)4; 265 (N.E.)1, (N.E.)2, (N.E.)4, (S.E.)2, (S.E.)3, (S.E.)4; 284, 285, 306 and parts of 307 (in one); 885 (N.W.)1, (N.W.)2, (N.W.)3, (N.W.)4, (S.E.)2, (S.E.)3, 2 (S.E.)4, (S.W.)1, (S.W.)4; 286 (N.W.)1, (N.W.)2, (N.W.)3, (N.W.)4, (S.W.)1, (S.W.)2, (S.W.)3; 290 (N.E.); 291 (N.E.)2 and 313 (N.W.)1, (in one); 307 (S.W.)2; 308 (N.W.)2, (N.W.)4, (S.W.)1, (S.W.)2; 309 (S.E.)4; 310 (N.E.)1 and 2 (in one), (N.E.)4, (S.E.)2; 311 (S.W.)1, 3 and 4 (in one), (N.W.); 312 (N.W.)1 and 2 (in one); 313 (N.W.)1, (N.W.)2, (N.W.)3, (S.W.)2, (S.W.)4; 314 (N.E.); 332 (N.W.)1, (N.W.)2, (N.W.)3, (N.W.)4 (S.W.)1 and (S.W.)3	F. & I.	¼, ½ & 1	D. E.	59	104	224	56	...	...	2,885	2,885	2,822 1	
Spirit-levelling Operations, Karáchi, 1893-94	F.	2	¼ D. E.	2	5	4	1	...	...	182	364	54 6	For Pamphlet of Spirit-levelled heights.

Ditto No. 8, Central Provinces and Orissa, 1891-92 and 1893-94	F.	2	¼ D. E.	1	2	4	1	...	...	175	350	63 5	,,	,,	,,
Views of Mussooree	F.	...	...	1	...	...	...	6	...	...	6	2 4			
Other Maps for Office use, Surveyor General's Office, etc.	F.	...	...	39	49	48	19	14	10	5,635	3,096	2,017 4			

Copies of Maps of other Departments taken for Departmental use.

Assam, Goálpára Forest Survey, Sheets Nos. 1 N.E./2, N.E./4, S.E./2; 2 N.E./4 and 9 N.W./3 (in one); 2 S.E./2 and 9 S.W./1 (in one); 7 N.E./4 S.E./1, S.E./2, S.E./3, S.E./4; S.W./4 and part of S.W./2 (in one); 8 N.E./1, N.E./2, N.E./3, N.E./4, N.W./1, N.W./2, N.W./3, N.W./4, S.E./1, S.E./2, S.E./3 and 9 N.E./1, (in one), 8 S.E./4, S.W./1, S.W./2, S.W./3, S.W./4; 17 N.W./1 and N.W./3 (in one).	...	¼	D. E. & ½ D. E.	28	...	...	...	...	...	280	280	97 2	
Berar Forest Survey, Melghát Táluk, Sheets Nos. 1, 2 and 3	...	1	D. E.	3	...	...	...	...	...	45	45	21 2	
Burma (Lower), Bondaung Working Circle	...	1	⅛ D. E.	1	...	...	...	...	...	10	10	1 12	
Ditto , Index to the Forest Survey in the Tenasserim Circle	...	32	⅛ D. E.	1	...	...	...	...	...	...	2	18 0	
Ditto , Salween and Ataran Forest Survey, Sheets Nos. 475 N.E./1 & 3 and N.W./2 & 4 (in one), S.E./1, S.E./3; 476; N.E./1, N.E./2, N.E./4, S.E./2; 548 N.W./1 & 3, and S.W./1	...	¼	D. E.	9	...	...	...	...	...	90	90	31 8	
Burma (Upper), Index to the Forest Survey in the Pyinmana District,	...	8	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Central Provinces, Bhandára Forest Survey, Sheets Nos. 92 N.E./3, N.E./4; S.E./3 and S.E./4 (in one), S.W./1, S.W./2, S.W./3, S.W./4; and 93 N.W./2	...	¼	D. E.	8	...	...	...	...	...	80	80	46 0	
Central Provinces, Index to the Forest Survey in the Bálaghát Division	...	8	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Central India Agency, Index to the Forest Survey in the Bundelkhand Division	...	8	¼ D. E.	1	...	...	...	...	...	5	10	2 0	
Chamba State, Index to the Forest Survey in the	...	8	⅛ D. E.	1	...	...	...	...	...	5	10	1 12	
Central Provinces, Index to the Forest Survey in the Narsinghpur Division	...	8	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Central Provinces, Index to the Forest Survey in the Raipur District.	...	16	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Ditto, Index to the Forest Survey in the Saugor Division	...	8	¼ D. E.	1	...	...	...	...	...	8	16	1 10	
Ditto, Jubbulpore Forest Survey, Sheets Nos. 84 S.E./3 & 4 and 85 N.E./1 & 2 (in one); 36 S.E./3, S.W./4; 87 N.E./1, N.E./2, N.E./3, N.E./4, N.W./2, N.W./4, S.E./1, S.E./2; 105 N.W./4, S.E./1 & 3, S.W./2, S.W./2, S.W./3, S.W./4; 106 N.E./1 & 2, N.W./2, S.E./2; S.W./1 and S.W./2 (in one); 107 S.E./4; 108 N.E./1, S.E./1, S.E./3, S.E./4, S.W./1 & 2, S.W./3, S.W./4; 109 N.E./1, N.E./2 & 4, N.W./1, N.W./2, N.W./3, S.E./1, S.W./1, S.W./3, S.W./4; 128 S.E./1 & 3, S.E./2, S.E./4; 129 N.W./4; S.E./1 and N.E./3 (in one), S.E./2, S.E./3 and 130 N.E./1 (in one), 129 S.E./4, S.W./1, S.W./2, S.W./3, S.W./4; 130 N.E./2, N.E./4, N.W./3, S.W./1 & 2; 131 N.W./1, N.W./3 and S.W./1 & 3	...	¼	D. E. and ½ D. E.	57	...	...	...	...	...	570	570	202 10	
Carried over	...	...	...	308	470	621	164	20	30	21,151	19,653	11,916 7	

Copies retained for office record, of maps, etc., requisitioned for by other departments, the cost of press pulls and stationery being all that is here charged to the Survey Department; the numbers in columns 5 to 8 therefore stand excluded from the totals.

Copies of Maps of other Departments taken for Departmental use—contd.

Specification of Plate or Print.	Progress made.	Photo-zincographic Printing.											Remarks.
		Scale of map.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.	
												R a.	
Brought forward	...	...	...	308	470	621	164	20	30	21,151	19,653	11,916 7	
Central Provinces, Raipur Forest Survey, Sheets Nos. 187 N.E./2, S.W./2; 188 N.E./4, S.E./3, S.E./4; 207 S.W./1 and S.W./3	...	¼	D. E.	7	...	...	...	...	...	70	70	24 8	
Clinometer and Height Indicator	...	...	1/16 D. E.	1	...	...	...	...	...	3	12	1 10	
Dehra Dún, Map of Kaboung Working Circle	...	1	D. E.	1	...	...	...	...	...	10	10	3 8	
Ditto, ,, Malhan Range	...	½	½ D. E.	1	...	...	...	...	...	10	10	2 2	
Ditto, ,, Nagsidh Working Circle	...	½	½ D. E.	1	...	...	...	...	...	10	10	2 2	
Ditto, ,, Ramgarh Range	...	½	½ D. E.	1	...	...	...	...	...	10	10	3 10	
Ditto, ,, Thano Working Circle	...	½	½ D. E.	1	...	...	...	...	...	15	15	5 10	
Ditto, ,, The Ganges Range	...	½	D. E.	1	...	...	...	...	...	10	10	5 12	
Ditto, ,, The Jumna Range	...	½	D. E.	1	...	...	...	...	...	10	10	3 8	
Ditto, ,, Tirsal Working Circle	...	½	½ D. E.	1	...	...	...	...	...	10	10	2 2	
Ditto, Mounted Rifle Bivouac Tents, Diagrams of, Sheets Nos. 1 and 2	...	...	¼ D. E.	2	...	...	...	...	...	10	20	3 4	
Germany, condition of Forests in the Duchy of Saxe Coburg and Gotha, Diagram, 1880—93	...	...	⅛ D. E.	1	...	...	...	...	...	8	16	1 7	
Germany, Tables showing the progress of Forest Conservancy in the Duchy of Saxe Coburg and Gotha during 11 years	...	...	⅛ D. E.	1	...	...	...	...	...	15	15	1 14	
Kumaun and Garhwál Forest Survey, Index Map of	...	8	⅛ D. E.	1	...	...	...	...	...	25	25	25 0	
Kumaun Forest Division, Map of	...	4	½ D. E.	1	...	...	...	...	...	10	10	3 12	
North-Western Provinces and Oudh, Index to the Forest Survey of Districts Bahraich, Gonda and Gorakhpur	...	16	⅛ D. E.	1	...	...	...	...	...	5	10	1 8	
Ditto ditto, Index to the Forest Survey Districts Kheri and Pilibhít	...	8	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Ditto ditto, Kheri Forest Survey, Sheet No. 100 N.E./3 & 4	...	¼	D. E.	1	...	...	...	...	...	10	10	3 8	
Ditto ditto, Pilibhít Forest Survey, Sheets Nos. 82 N.E./2 & 4; S.E./2 and part of 98 S.W./1 (in one); 82 S.E./4 and 98 S.W./3 (in one); 97 S.W./3; 98 N.W./1, N.W./2, N.W./3, N.W./4; S.E./1 and S.W./2 (one); S.E./3 and 99 N.E./1 (in one)	...	¼ and 1	D. E.	10	...	...	...	...	...	105	105	37 14	
Punjab Forest Survey, Bashahr State, Sheets Nos. 331 S.E./2, S.E./3, S.E./4, S.W./2, S.W./4; 332 N.E./1, N.E./3, S.E./1; 333 N.W./2; 346 N.E./3; S.E./4 and 352 S.W./3 (in one); and 347 N.E./3	...	¼	D. E. & ½ D. E.	12	...	...	...	...	...	120	120	76 2	
Punjab, Bashahr Forest Triangulation Chart, Sheet No. 332	...	1	D. E.	1	...	...	...	...	...	15	15	4 2	
Ditto, Index to the Forest Survey in the Bashahr Division	...	8	¼ D. E.	1	...	...	...	...	...	...	2	9 0	
Topographical Symbols, Diagram	...	...	.....	1	...	...	...	...	...	5	10	1 14	
Other Maps	...	2 and 4	D. E.	6	...	...	...	...	...	319	88	81 12	
Totals	...	...	.....	364	470	621	164	20	30	21,956	20,268	12,231 0	

* Additional prints of previous publications; D. E. represents double elephant; F. represents finished; I. represents in press.

CORRESPONDENCE SECTION.—The work in this section has been carried on as usual.

STORES, WORKSHOPS AND OBSERVATORIES SECTION.—A good deal of extra work has been thrown on the stores part of this section owing to the fitting out of the survey detachments for the Chitral Relief Force, the Pamir Delimitation Commission and the Anglo-Afghan Boundary Commission. The workshops have been busy in various ways connected with the reconstruction of the office. In the observatories the usual time observations were taken, the chronometers rated and kept in order, and other miscellaneous works done including the experiments for variation of the values of micrometer screws already mentioned.

SOLAR PHOTOGRAPHIC SECTION.—The details of the work of this section are given below:—

Table showing the number and character of negatives.

1894-95.	Number of days.				Number of Negatives.										Number of working days when solar phenomena were	
		Failures.			Solar Phenomena.								Total.			
	When negatives were taken.	From bad weather.	From various causes.	Total.	Spots and faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	28	3	...	31	52	...	...	...	...	...	...	...	52	...	28	...
November	28	2	...	30	50	...	...	...	...	...	...	...	50	...	28	...
December	22	9	...	31	35	...	...	...	...	...	...	...	35	...	22	...
January	21	10	...	31	34	...	...	...	...	...	...	...	34	...	21	...
February	27	1	...	28	48	...	...	...	...	...	...	...	48	...	27	...
March	29	2	...	31	52	...	...	...	...	...	...	...	52	...	29	...
April	27	3	...	30	47	...	...	...	...	...	...	...	47	...	27	...
May	31	...	...	31	58	...	...	...	...	...	...	...	58	...	31	...
June	28	2	...	30	47	...	...	...	...	...	...	...	47	...	28	...
July	26	5	...	31	44	...	...	...	...	...	...	...	44	...	26	...
August	18	13	...	31	33	...	...	...	...	...	...	...	33	...	18	...
September	28	2	...	30	51	...	...	...	...	...	...	...	51	...	28	...
TOTAL	313	52	...	365	551	...	...	...	...	...	...	...	551	...	313	...

Nine hundred and eighty-two silver prints of the 8-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table showing the visibility of Sun at Dehra Dun and Greenwich.

Year.	At Dehra Dun.			At Greenwich.		Remarks.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days on which sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88	205	
1889-90	320	78	45	1888-89	182	
1890-91	303	99	62	1889-90	212	
1891-92	304	100	62	1890-91	224	
1892-93	292	100	73	1891-92	219	
1893-94	304	100	61	1892-93†	220	† Year ending 10th May 1893, obtained from the report to the Board of visitors.
1894-95	313	100	52	1893-94	Not obtainable.	
Mean	306	...	58	...	199	

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement showing the work performed during 1894-95.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
Standard Maps.		In. M.	
Hazara Expedition, 1891-92, sheets Nos. 1, 2 and 3	3	1=$\frac{1}{4}$	Corrections in hand.
North-Eastern Trans-frontier sheet No. 7	1	1=4	Corrections completed. In hand.
Punjab Survey, Sheets Nos. 285 $\frac{N.W.}{2}$; 285 $\frac{N.W.}{4}$	2	1=$\frac{1}{4}$	Corrections completed. Final press order given.
(Revised editions), Sheets Nos. 285 $\frac{N.W.}{1}$; 285 $\frac{N.W.}{2}$; 285 $\frac{N.W.}{3}$; 285 $\frac{N.W.}{4}$	4	1=$\frac{1}{4}$	Corrections completed for reduction to $\frac{1}{8}$ scale. In press.
Gujarat Survey, sheet No. 27, Secs. N.W.; N.E.; S.W.; S.E.	4	1=$\frac{1}{2}$	Corrections completed. Final press order given.
Gujarat Survey, Sheet No. 28, Secs. N.E.; S.E.	2	1=$\frac{1}{2}$	
Level sheets Nos. 67, 74 and 88	3	1=2	Compilation in hand.
Plans of Cities and Cantonments.			
Dehra Municipality and Cantonment (2nd Edition)	3	1=$\frac{1}{12}$	In hand.
Plan of Mussoorie Cemetery, October 1894	1	1=20 ft.	Completed headings and foot-notes. Final press order given.
Index Maps.			
Triangulation Chart of India	1	1=96	Brought up to date for Annual Report.
To illustrate progress of Nos. 14 and 18 Parties	2	Various	Ditto ditto.
Index to Charts of Principal Triangulation of Burma	1	1=40	Ditto ditto.
Index to Level Sheets of G. T. Survey	1	1=64	Ditto ditto.
Index to Forest Surveys in District Damoh	1	1=12	Completed headings and foot-notes Final press order given.
Charts.			
Triangulation Chart, Kathiawar Meridional Series	2	1=4	For reduction to $\frac{1}{8}$ scale. Final press order given.
No. 45, Preliminary Chart of Indus Delta Coast Triangulation	1	1=4	Plotted for reproduction. Final press order given.
No. 5, Preliminary Chart, Mandalay Meridional Series	1	1=4	Completed headings and foot-notes. Final press order given.
Triangulation Chart Great Arc Series Section 8° to 18°	4	1=4	In hand.
No. 44, Preliminary Chart of Indus Delta Coast Triangulation	1	1=4	In hand.
Miscellaneous.			
Tidal map of Cochin	1	1=7	Completed. Final press order given.
Tidal maps of Port Albert Victor, Tuticorin, Galle, Negapatam, Madras, False Point, Akyab, Amherst, Moulmein, Trincomallee, Bhavnagar, Minicoy, Bombay, Rangoon, Dublat, Kidderpore, Diamond Harbour, Chittagong, Vizagapatam, Mormugao, Colombo, Cocanada, Nawanar, and Pamban Pass	24	Various	In hand.
Map of Black Mountains and adjoining country	1	1=2	In hand.
Other maps	20	Various	Touched up for photography, and completed as regards headings, foot-notes and references, etc., for press.
Maps coloured	1717	„	

Statement showing the work performed during 1894-95—contd.

MAPS EXAMINED.

	No. of Sheets.
Standard Original Maps	70
Charts	3
Miscellaneous Maps	58
Photographic proofs of Standard Sheets and other Maps	193
TOTAL	324

N.B.—In addition to the above, other miscellaneous duties have been performed, such as completing Central Provinces and Punjab Survey, original sheets, original maps of Kalka Town, two Triangulation Charts of No. 18 Party and 1 Spirit Levelling Operation sheet in respect to headings, foot-notes, symbols, etc., for press; supplying tracings of margins of sheets to Simla Drawing Office and No. 18 Party; examination and custody of records; making all the despatches of maps, etc., etc.

Statement of work done for other Departments during 1894-95.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
		In. M.	
Standard Maps.			
Forest Surveys	96	1 = ¼	Completed headings, foot-notes and references. Final press order given for Forest Department.
Index Maps.			
Forest Surveys	1	1 = 8	Ditto ditto ditto.
Charts.			
Forest Surveys	1	1 = 4	Ditto ditto ditto.
Miscellaneous.			
Forest Surveys	3	Various	Ditto ditto ditto.
Quarter Master General, Intelligence Branch.	2	1 = 4	Compiled and final press order given.
Foreign Office	2	1 = 2	Completed headings, foot-notes, etc. Final press order given.
Field Sheets of Gurgaon Civil Station	18	1=50 ft.	Plotted for the Deputy Commissioner, Gurgaon.
Ditto ditto Environs	18	1=100 ft.	
Ditto ditto of Sohna Town and Environs.	12	1=50 ft.	
Clinometer Height Indicator	1	...	Prepared and final press order given for Imperial Forest School.

Statement showing the value of work done for other Departments during 1894-95.

DEPARTMENTS.	Value.
	R a. p.
Forest Department	276 0 0
Quarter Master General's Department, Intelligence Branch	69 13 0
Foreign Department	46 10 0
Military Department	1 5 0
TOTAL	393 12 0

G. I. C. P. O.—No. 17 S. G.—10-4-96.—459.

1896.

File No. 76 of 1896.

GOVERNMENT OF INDIA.

Serial No. 2.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

RESOLUTION.

No. $\frac{7}{76-2}$.

Dated Simla, the 3rd July 1896.

SUBJECT.

General Report on the operations of the Survey of India Department for the year 1894-95.

G. C. Press, Simla.—No. 241 R. & A. D.—3-7-96.—715.

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture (Land-Surveys), dated 3rd July 1896.

READ—

The General Report on the operations of the Survey of India Department during the year 1894-95.

RESOLUTION.

The field operations during the year under review were carried on by 20 parties (of which two were double parties) and seven small detachments of the Imperial Survey Department and also by nine detachments of the Forest Survey Branch.

The various classes of work on which the Imperial Survey parties were engaged are shown below :—

	Number of parties employed.	Number of detachments employed.
1. Trigonometrical	1	0
2. Topographical	5	3
3. Forests (excluding the Forest Survey Branch)	4	0
4. Cadastral	6 (two double)	0
5. Traverse	1	1
6. Scientific	3	0
7. Geographical	0	3
Total ...	20	7

Thus eleven parties and one detachment were engaged on remunerative operations connected with land or forest revenue, as compared with eleven parties and two detachments in 1893-94.

2. A comparative statement is given below of the aggregate areas surveyed during the years 1893-94 and 1894-95 under each class of work :—

Class of work.	Areas Surveyed in square miles. 1893-94.	1894-95.
Topographical	16,072	21,588
Forests Imperial Survey Department ...	2,522	2,612
Forest Survey Branch	1,433	1,616
Cadastral	8,280	6,934
Geographical	99,170	92,631
Total ...	1,27,477	1,25,381

The above figures do not include the traverse survey operations carried on for the purpose of furnishing a basis for field surveys under the Settlement Department, or the skeleton surveys of village boundaries, or the large scale surveys of cities.

3. The trigonometrical survey party carried the principal triangulation of Upper Burma northwards as well as westwards through Manipur and Assam. One section of this party extended the Mandalay Meridional series over a direct dis-

tance of twenty miles to the parallel of 25° N. latitude. A second portion of the party started and carried as far as Manipur a longitudinal series from the eastern stations of the Cachar Branch series, which will be carried eastwards till it connects with the Mandalay Meridional series. A third small section of the same party continued the secondary triangulation and finished the work of fixing beacons along the Indus delta.

4. Topographical surveys were continued by three parties in the Bombay Presidency, Baluchistan and the Himalyas; and two other parties, which had previously been employed exclusively upon the preliminary geographical survey of Upper Burma, were engaged during the year under report on the 1 inch survey of the province and are now classed as regular topographical parties. Of the three topographical detachments, one detachment finished the survey of the river Indus in Sind, the second was employed on the survey of the permanently settled portions of the Puri, Cuttack and Balasore districts in Bengal, and the third detachment accompanied the Waziristan Delimitation Commission. Some topographical surveying was also executed by the small survey parties which accompanied the Pamir Commission and the Chitral Relief Force, and by the cadastral parties in Burma and the Forest Survey Branch in the Punjab.

5. During the year under review four Imperial Survey parties were employed on forest surveys in the Central Provinces, in Lower Burma, and in the Bombay and Madras Presidencies. Of the Forest Survey Branch, four detachments were employed in the Central Provinces, one in the Punjab, two in the North-Western Provinces and one each in Upper and Lower Burma.

The work completed amounted to 2,612 square miles surveyed by Imperial parties and 1,616 square miles by the Forest Survey Branch. This outturn is in both instances in excess of that of any previous year, and brings up the total area covered to 31,084 square miles. An even more satisfactory feature, however, of the work done in 1894-95 is the reduction in the cost per square mile of forest area surveyed, whether by the Imperial Survey or by the Forest Survey Branch, which is apparent in every province save Burma, and is in most cases due to the gradual substitution of a cheaper agency, and the spreading of the cost of supervision over larger areas. In the Central Provinces, where the cost of forest surveys forms a heavy burden on the limited forest revenue, the rate was lowered from Rs. 89 per square mile in 1893-94 to Rs. 67; while considerable reductions have taken place in both Bombay and Madras. In the latter Presidency the outturn in square miles has steadily increased from 168 square miles in 1888-89 to 971 in the present year, with a rate which has gradually fallen from Rs. 162 to Rs. 67 per square mile.

6. Cadastral surveys were carried on by two double parties in Bengal, by three parties in Burma, and by one party in Assam. The aggregate area surveyed in all three provinces amounts to 6,934 square miles, exclusive of areas over which traverse surveys have been made in advance of the cadastral survey. This outturn is smaller than that of the year 1893-94, owing to a reduction in the survey establishment. The cost per acre varies greatly from district to district and from province to province, depending largely upon local conditions.

7. One party in the Central Provinces and a detachment in the North-Western Provinces were employed on traverse Surveys with the object of furnishing a skeleton basis for a cadastral Survey to be made by local agency. The aggregate area so traversed was 5,018 square miles.

8. Two astronomical parties were engaged in the determination, by the electro-telegraphic method, of the difference of longitude between Greenwich and Karachi. Arcs of longitude were successfully measured between Karachi, Jask and Bushire. The scene of operations was afterwards changed to Europe and the arc between Greenwich and Potsdam was completed. It is estimated that the whole series of observations will be completed this season.

9. Tidal and spirit levelling operations were continued by one party. Observations with self registering tide gauges were taken at thirteen stations in India, Burma, the Persian Gulf, Ceylon, the Andaman Islands and Minicoy; while the junction of all the tidal stations along the East Coast of India was completed by a line of levels carried from Cuttack to Vizagapatam.

10. Geographical surveys and reconnaissances were carried on in Persia, on the Perso-Baluch Frontier, and in Arabia; in Upper Burma, including the Northern Shan States and in Mekong; on the Pamirs, and in the Chitral country; as well as in the Kokang State, China, and on the Burma-Siam boundary. The aggregate area geographically surveyed was 92,600 sq. miles, and the operations have largely added to the information available concerning the geography of trans-frontier tracts. The Mekong triangulation was connected with that of Siam, while the Indian and Russian systems were brought into connection on the Pamirs with the most satisfactory results.

11. The work done in the various Head-Quarters Offices was satisfactory. In the Drawing Office a second edition of the map of Burma on the 16-mile scale and a map of the Punjab on the same scale were completed. The Engraving Office completed seven new plates for the Atlas of India and ten district maps for Administration Reports. Good progress was also made with the preparation of a large map of India without hills, a new railway map on the 80-mile scale, the Provincial maps of the Madras and Bombay Presidencies, of Gujrat, the Punjab and Kashmir, and Mysore and Coorg, and of the map of the City of Calcutta.

The value of the extra-departmental work done in the Photographic and Lithographic Offices increased from Rs. 71,141 to Rs. 76,534. The Mathematical Instrument Department repaired more instruments than in any previous year. The number of instruments issued during the year 1894-95 was larger, though the value of the issues was smaller, than in the preceding year.

12. The Survey of India Department was reorganized in 1895 in order to carry out the general principles laid down by the Public Service Commission of 1886-87, and to provide a more satisfactory basis for a simple and uniform scheme of leave and pension rules. It was divided into three distinct services known respectively as (*i*) the Imperial Service, consisting of officers who will be either transferred from the army or recruited directly from England; (*ii*) the Provincial Service, to be recruited exclusively in India, and (*iii*) the Subordinate Service, which will remain in every respect on the same footing as before. The new scheme provides for the transfer of ten appointments from the old "Senior Division" to the Provincial Service, the remainder of that Division, together with the administrative appointments at the head of the Department, constituting the Imperial Service. The line between the Provincial and Subordinate Services has been drawn immediately below the old Junior Division, and the Provincial Service consists of the Junior Division together with the ten appointments transferred from the Senior Division.

13. Upon the retirement of Sir Henry Thuillier on the 26th March 1895, the value of whose services has already been acknowledged by the Government of India, Colonel C. Strahan, R.E., was appointed Surveyor-General. The Government of India desire to acknowledge his efficient administration of the Department, and also the excellent work done by Colonel J. E. Sandeman, Deputy Surveyor General in charge of the Revenue Branch, particularly in connection with the cadastral survey of Behar. They endorse the Surveyor General's opinion of the high character of the work done by the officers of the Department.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor General of India, the Inspector General of Forests, the Local Governments and Administrations noted on the margin, and to the Foreign, Military and Public Works Departments.

Madras.
Bombay.
Bengal.
North-Western Provinces and Oudh.
Punjab.
Central Provinces.
Burma.
Assam.
Coorg.

Ordered also that the Resolution be published in the supplement to the *Gazette of India*.

(True Extract.)

DENZIL IBBETSON,

Officiating Secretary to the Government of India.

00134602

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Government of Maharashtra

on 01 February, 2020